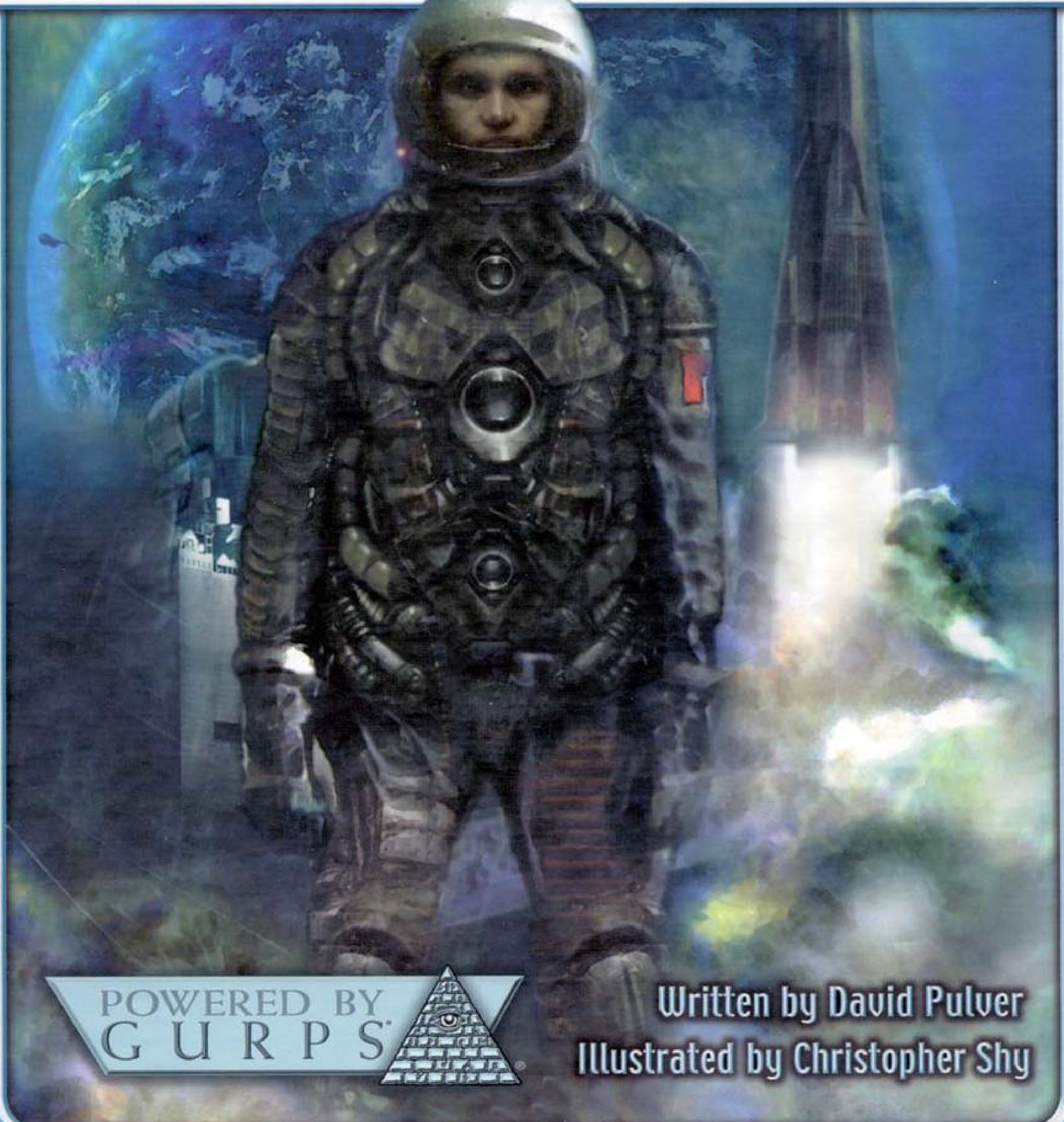
TRANSHUMAN™ SPACE



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STEVE JACKSON GAMES

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STEVE JACKSON GAMES

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INTRODUCTION

We live in the 21st century. In the coming decades, technologies such as genetic engineering, artificial intelligence, and nanotechnology are poised to transform humanity. Unfolding before us is a strange new world – nightmarish to some, utopian to others – in which we shall have the power to reshape our children's genes, build machines that think, and perhaps even upload our minds into computers.

Simultaneously, we are emerging into an era where the colonization of space is at last becoming possible. Space tourism, mining the moon and asteroids, a settlement on Mars: all are dreams poised to take wing.

Transhuman Space is a synthesis of these two visions, a world in which they fuse to forge a new destiny for mankind. Neither utopia nor dystopia, it is a place of hopes, fears, and new frontiers. Welcome to 2100!

THE TRANSHUMAN SPACE LINE

This book is the first in a line of worldbooks and adventures that will develop the ***Transhuman Space*** setting. It provides an introduction and overview of the setting, guidelines for creating characters, and rules for equipment and spacecraft. Supporting this core book are a series of world books focusing on different parts of the solar system, including ***Transhuman Space: In the Well*** (Mars, Venus, and Mercury), ***High Frontier*** (Luna, Earth orbit, and the Lagrange colonies), ***Fifth Wave*** (Earth), and ***Deep Beyond*** (the asteroid belt and outer solar system). Also available is the first ***Transhuman Space*** adventure, ***Orbital Decay.***

Additional Material

The ***GURPS Basic Set*** and ***GURPS Compendium I*** are helpful, but not required to use this worldbook. GMs will also find ***GURPS Bio-Tech*** a source of useful rules and ideas. Some (but by no means all) of the fictional vignettes in ***Bio-Tech*** take place in the ***Transhuman Space*** world; a few offer a glimpse of its future. ***GURPS Compendium II, Ultra-Tech 2,*** and ***GURPS Vehicles,*** *Second Edition* also have rules and gadgets that may be helpful to GMs, but neither they nor ***Bio-Tech*** are required.

On the Web, see **www.sjgames.com/transhuman/** for more information on the whole ***Transhuman Space*** line.

ABOUT THE AUTHOR

David L. Pulver is the creator and line editor of the ***Transhuman Space*** series. A writer, editor, and game designer, he was born in Canada, and lived in England and New Zealand. David is the author or co-author of over 40 books, including ***GURPS Bio-Tech, GURPS Vehicles, GURPS Technomancer, BESM,*** *Second Edition,* and ***Big Robots, Cool Starships.*** His interests include science fiction, anime, and history.

ABOUT GURPS

Steve Jackson Games is committed to full support of the ***GURPS*** system. Our address is SJ Games, Box 18957, Austin, TX 78760. Please include a self-addressed, stamped envelope (SASE) any time you write us! Resources include:

Pyramid (**www.sjgames.com/pyramid/**). Our online magazine includes new ***GURPS*** rules and articles. It also covers ***Dungeons and Dragons, Traveller, World of Darkness, Call of Cthulhu***, and many more top games – and other Steve Jackson Games releases like ***In Nomine, Illuminati, Car Wars, Toon, Ogre Miniatures***, and more. *Pyramid* subscribers also have access to playtest files online!

New supplements and adventures. ***GURPS*** continues to grow, and we'll be happy to let you know what's new. A current catalog is available for an SASE. Or check out our website (below).

Errata. Everyone makes mistakes, including us – but we do our best to fix our errors. Up-to-date errata sheets for all ***GURPS*** releases, including this book, are available from SJ Games; be sure to include an SASE. Or download them from the Web – see below.

Gamer input. We value your comments, for new products as well as updated printings of existing titles!

Internet. Visit us on the World Wide Web at **www.sjgames.com** for an online catalog, errata, updates, Q&A, and much more. ***GURPS*** has its own Usenet group, too: rec.games.frp.gurps.

GURPSnet. This e-mail list hosts much of the online discussion of ***GURPS***. To join, e-mail majordomo@io.com with "subscribe GURPSnet-L" in the body, or point your web browser to **gurpsnet.sjgames.com**.

The ***Transhuman Space*** web page can be found at **www.sjgames.com/transhuman/**.

Get GURPS Free!

This book includes core roleplaying rules. It was designed for use with the ***GURPS Basic Set*** . . . but you can also use it with ***GURPS Lite,*** the condensed version of the core ***GURPS*** rules, found on pp. 207-238. We also offer ***GURPS Lite*** for free on our website! Just go to **www.sjgames.com/gurps/lite/** to download the PDF version. Or, when you order anything from our website, you can request a free ***GURPS Lite*** with your order.

Page References

Rules and statistics in this book are specifically for the ***GURPS Basic Set,*** *Third Edition.* Any page reference that begins with a B refers to the ***GURPS Basic Set*** – e.g., p. B102 means p. 102 of the ***GURPS Basic Set,*** *Third Edition.* Page references that begin with CI indicate ***GURPS Compendium I.*** Other references are BIO for ***GURPS Bio-Tech,*** CII for ***GURPS Compendium II,*** and VE for ***GURPS Vehicles,*** *Second Edition.*

For a full list of abbreviations, see p. CI181 or the updated web list at **www.sjgames.com/gurps/abbrevs.html**.

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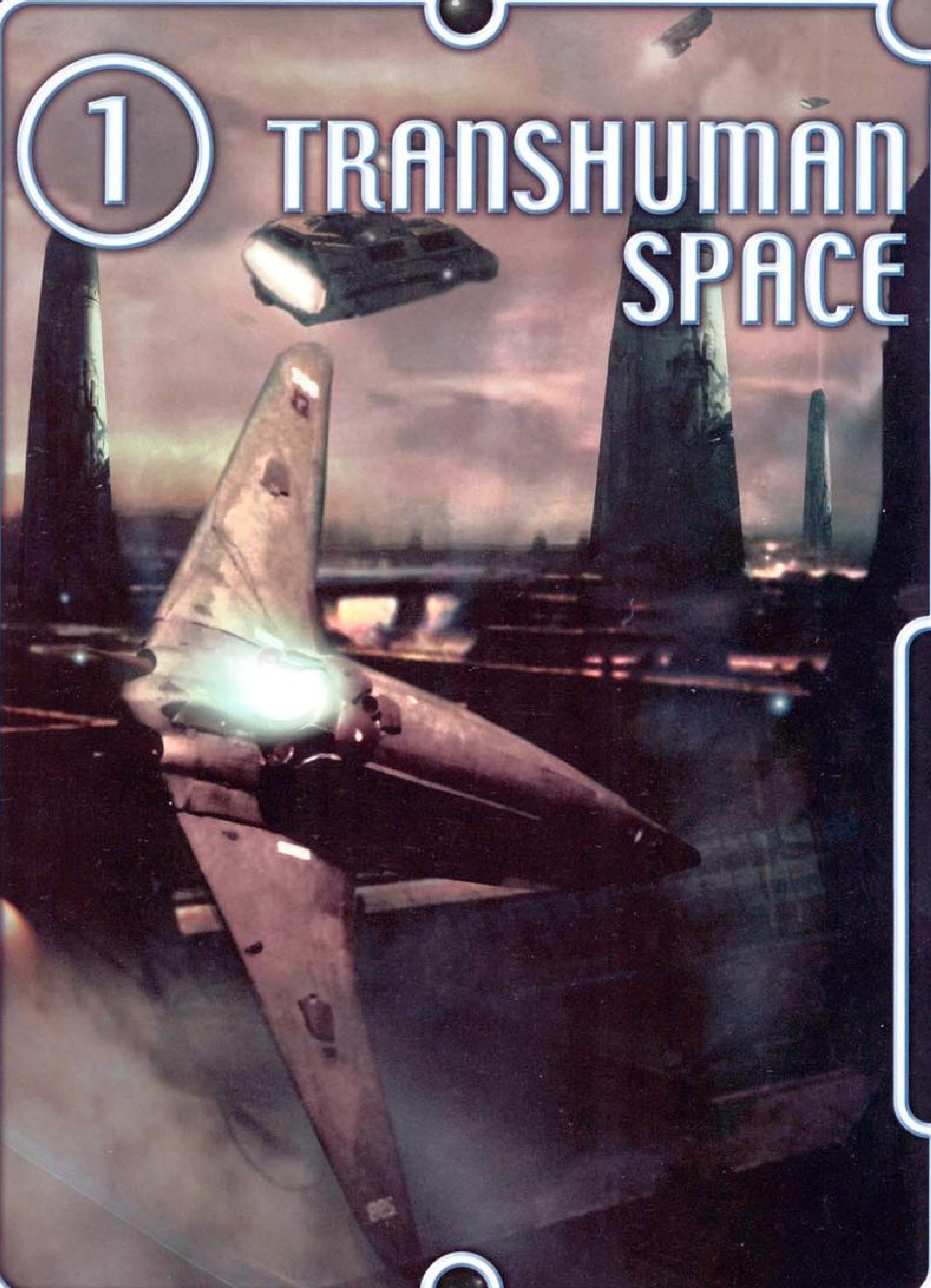
TRANSHUMAN SPACE



On November 2, 2099, an informer led Aletheia Station police to Bobby Kravchenko, a freehauler captain suspected of trafficking in contraband bioroids. A sting resulted in Kravchenko's arrest and the freeing of six ***Tianyi****-model pleasure bioroids from the USV* ***Pride of Newcastle.*** *However, magnetic resonance imaging revealed Kravchenko was a victim, not a perpetrator. The real criminal was a puppeteer infomorph implant installed in Kravchenko's brain. Now charged with murder, it was identified as the digital ghost of Nikki Siu Zhang, a former helium pirate. Edited into cooperation, Zhang admitted to buying the bioroids from Morrigan's Rock, an independent gas station that, she believed, doubled as an outpost of the notorious Martian Triads.*

Hir Majesty's Government equated bioroid trafficking with slavery, especially now that Hawking Industries was facing heavy competition from its rivals' bioroid labor. The stationmaster requested that the Royal Navy Space Service deliver a clear message that such activities would not be tolerated in the Main Belt. Their chosen messenger was Captain Penelope Ironside's Task Force Whisky, consisting of the space-dominance vehicle HMS ***Resolution*** *carrying a troop of Royal Marine Commandos in Centurion battlesuits.*

An 20-hour fusion burn and three weeks later, HMS ***Resolution*** *entered orbit around Morrigan's Rock, only to come under laser fire from automated defenses.* ***Resolution****'s particle beam quickly suppressed them, but as soon as the Royal Marines stormed the airlocks, it was clear they had kicked over a hornet's nest!*

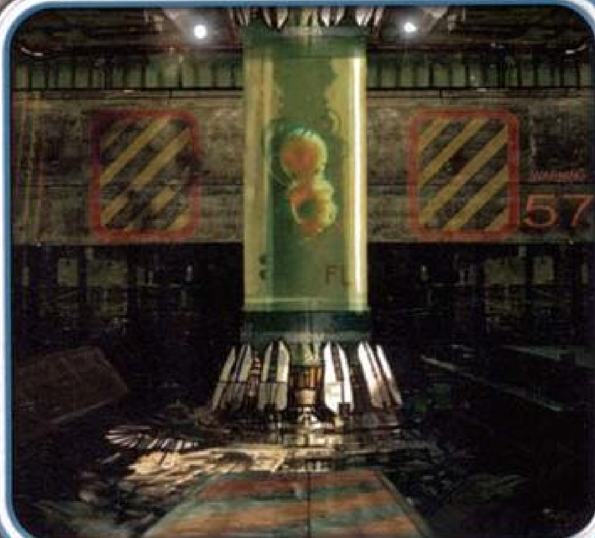
Fiercely engaged by dense swarms of black-market ***Wespe*** *and* ***BlutMuzak*** *microbots, the first assault section dissolved moments after taking the docks. The second and third sections penetrated the station's inner corridors, but came under withering fire from* ***Felicia****-series combat bioroids. After overcoming this resistance, the Royal Marines reached the asteroid's living and work quarters, only to find something shocking . . .*

This was no smuggler's drop station – it was a nest, a full-scale birth factory. The interior was filled with gene sequencers and biogenesis tanks. They held skeletal, half-formed, and fully adult bioroids, the latter already immersed in virtuality training simulations. Some were pleasure models, minds and bodies warped to satisfy jaded tastes of farhaulers and vacworkers. Others were combat bioroids, pirated from decades-old Biotech Euphrates designs.

The crew boss running the station killed himself rather than surrender. He was too late. ***Resolution****'s surgeon acted quickly; the bush robot salvaged enough of the boss's neurons to create a mind emulation. The uploaded memories confirmed this was a Martian Triad operation, set up by yet another cross-sex clone of the notorious Dr. Mara Omokage. The combat bioroids were destined for sale to the Europa Defense Front, living weapons intended to wage their bloody proxy-war against the Green Duncanite pantropists for control of Europa's destiny. He also revealed even more disturbing intelligence: Morrigan's Rock was just one of a dozen asteroid bio-factories in existence, their exact locations known only to the Martian Triad's senior cadres.*

In her cabin aboard ***Resolution,*** *Captain Penny Ironside read the interrogation transcript and raised one eyebrow. The Martian Triads . . . combat bioroids . . . and a Europa connection. This mess had "Agency" written all over it. It was time she had a word with America's SIA.*

In the last decade of the 21st century, humanity faced two of its greatest challenges. The first was the transformation from a single, evolved species to a multitude of artificial races. The second was the settlement of the vast reaches of the solar system. Away from the prying eyes of Earth, space-going transnationals developed technologies that governments feared to investigate but could not ignore, while bizarre posthuman cultures bloomed like exotic flowers. It was a time of wealth and adventure, of transformation and terror. It was the age of ***Transhuman Space***.



The ***Transhuman Space*** timeline postulates no cataclysms that cause the fall of civilization. It paints an optimistic picture of the future: the mass of humanity shares in the fruits of progress, while technological advances have neither choked in regulations nor devoured their creators. Resources are not running out, and fewer people spend their lives suffering the privations of sickness or hunger than in the 20th century. Through strenuous effort, cancer and AIDS were defeated, the nuclear doomsday clock has been stopped, and even the ozone layer is starting to recover.

TIMELINE: TO 2020

Up to 2010: China embarks on a manned space program, putting several *yuhangyuan* ("space navigators") into orbit and on the moon. The first human clone is born. The United States commits to a Mars mission.

2011: Sales of new wearable computers (using a visor display and belt computer) exceed those of desktop or notebook systems. The Terrestrial Planet Finder (TPF) space infrared interferometer begin scanning stars within 50 light years.

2012: North and South Korea set date for reunification.

2013: TPF discovers an Earth-like planet orbiting the G5 yellow dwarf star 61 Virginis, 27.8 light years away. It is named "Virginia." Later, more advanced sensors locate other habitable worlds around farther stars.

2014: U.S. space development firm Columbia Aerospace begins operating a reliable laser-launch service for commercial microsatellites.

2015: Russia joins manned Mars program. Antibiotic-resistant pneumonia pandemic kills 7 million worldwide. Revised Outer Space Treaty is drafted, making it easier for corporations or states to lay claim to extraterrestrial resources.

2016: South African conglomerate Ithemba Biotechnologies distributes a cheap broad-spectrum AIDS vaccine in Africa. China and Taiwan negotiate date for peaceful reunification. China announces its own Mars program.

2017: The brown dwarf Xiang-63 is discovered. Parallax measurement reveals it is quite close to Sol, less than a light-year away.

2018: The *Long March VI* rocket lofts China's first space lab module into orbit. European Union increases fusion power budget. Biotech Euphrates is founded, with a then-radical commitment to human gengineering.

2019: The commercial *Aristaeus* mission lands several thousand tiny robots on Mars, for both science and teletourism. A separatist party forms in western Canada, believing their destiny lies with Asia-Pacific.

2020: Most cars use hybrid gas-electric or fuel cell engines. The genetic testing of unborn children and use of genetic engineering to "gene-fix" monogenetic hereditary defects is common in affluent nations. China lands robots on Mars and Phobos. United States and Russia establish a service station facility at the Earth-Luna L4 point.

Still, the world of 2100 is no utopia. Far too many of Earth's species became extinct before people thought to preserve their genes against a more enlightened future. Global warming is a constant battle, not from greenhouse gases, but from thermal emissions produced by cheap fusion power. Access to space has opened up new resources and opportunities, but created conflicts over who will use them, and for what. Wearable or implanted computers, augmented reality, virtual telepresence, and artificial intelligence have given everyone their own set of personal aides or companions, banishing "twen-cen" concepts like "office" and "school." Loneliness is rare. Rarer still is privacy, on a crowded Earth where every glance from a passer-by means being scanned by digital video and profiled by inquisitive data-mining software.

If anything, the gap between rich and poor has become greater. A wealthy person does not just have a better education – he may have better *genes* as well. A poorer person may have a wearable "virtual interface" comp, but if he can't get work because his parents couldn't afford to tweak his genes for the aptitudes others have, he's still out of luck. With more and more jobs going to artificial intelligences, the competition for work can be fierce, especially as medical longevity has made "retirement" and "pensions" things of the past. Many countries have shortened work weeks and added social assistance programs that seem extravagant by 20th-century standards, not in the name of charity but social stability.

In the advanced Fifth Wave nations, the older generation spends much of their income on investments and health care. For the well-off, "break-even" has been achieved: thanks to ever-advancing biotechnology, every year a person lives, his life expectancy is increased by an equivalent amount. There are millions of people a century old – or more – and still active and healthy. Many nations are dominated by an upper stratum of conservative, potentially immortal plutocrats. The good news? More corporations and governments now plan for the long term, rather than the next quarter or the next election. The bad? Waiting for the "old guard" to retire or die out is no longer an option, in politics, business, or academia. As a result, even moderate activists and reformers often resort to extreme measures, and radical social movements are making new strides.

TIMELINE: 2021-2030

2021: Columbia Aerospace opens an equatorial launch facility in Quito, Ecuador; by 2100, it will be Earth's busiest spaceport. Transgenic glow-in-the-dark pets become a fad in Japan.

2022: European and Japanese space agencies use robot "cybershells" to build a distributed-array observatory at Tsiolkovsky crater on Luna's farside. Provision is made for a small manned base. Mainland China and Taiwan are reunited.

2023: Tissue engineers grow functional human hearts for transplant. Every organ in the body (except the brain) is now replaceable. In reaction to peaceful Chinese and Korean reunifications, the United States begins reducing its military presence in Asia.

2024: The U.S.-Russian *Horus I* manned Mars mission is launched. Sergey Zarubayev becomes dictator of Kazakstan. Thanks to advanced medical technology, he will retain his death-grip on life and power for the rest of the century.

2025: China's *Chaosheng* manned Mars mission is launched, even as the U.S.-Russian *Horus I* mission ends in tragedy.

2026: Chaosheng spacecraft arrives, and Wen-Xuan Liang is the first human to set foot on Mars.

2027: Columbia Aerospace and Nanodynamics begin construction of orbital industrial park. Belgium is the first of several European nations to dissociate into smaller self-governing regions within the European Union.

2028: Multiple follow-up expeditions begin arriving on Mars. First baby born in Earth orbit.

2029: Industrial combines Vosper-Babbage and Tenzan Heavy Industries finance a series of manned and unmanned missions to near-Earth asteroids.

2030: Argentine oil drilling near Antarctica sparks new conflict with United Kingdom. Japan and Korea sign mutual-defense treaty.

That's the hyper-developed world. In less fortunate regions, only a tiny elite can afford longevity or genetic enhancement, and computer implants and infomorphs do not enhance the citizens – they monitor and control them. That's if you're lucky enough to live in a well-organized tyranny. There are regions where the Fourth and Fifth Waves did not float civilization, but drowned it: these shards of broken dreams can resemble the worst cyberpunk nightmare, polluted by the detritus of runaway nanotechnology and genetic engineering. AIDS may no longer stalk Africa, thanks to Ithemba's bioengineers, but that is scant comfort to nano-plague victims in Central Asia or brainbug addicts in Istanbul, São Paulo or East L.A.

Discrimination by sex or skin color is a footnote in the history books, or so people like to believe, but *speciesism* and enslavement of sapient constructs is alive and well. Nor is the world at peace. Conventional warfare fought with robot tanks, microbot swarms, orbital kinetic kill clusters, and old-fashioned rifles left a million dead between 2080 and 2100. Predatory infomorphs – orphaned military weapons from the Pacific War (p. 22) – hide in the dark corners of the global datasphere. The discovery of primordial black holes has raised a specter of terrible new weapons that could not merely poison or devastate our planet, but utterly destroy it.

Yet things have changed. A future that might have been a zero-sum game on Earth has suddenly become infinite. For the first time in over a century, there is a wild new frontier: a place to rediscover a pioneer spirit, confront the challenge of alien environments, and build new lives, new societies, and new realities.

Timeline: 2031-2040

2031: Referendum in British Columbia and Alberta favors separation from Canada. Euro-Japanese "Lunar consortium" begins construction of an ice-mining base, Shackleton Station, on the Lunar south pole.

2032: Vosper-Babbage and Tenzan Heavy Industries begin installing mass drivers to move near-Earth asteroids into the L4 and L5 points.

2033: The first baby is born on Mars. Biotech Euphrates markets gene-enhanced dogs. First operational fusion reactor goes online. British Columbia and Alberta separate from Canada, and will go on to form the Union of Alberta and British Columbia ("ABC").

2034: United Nations collapses due to lack of funds and support from major powers. Australian academic Kyle Porters sets out the tenets of "information socialism." He argues for a society in which patents and intellectual properties are free, but inventors and creators are subsidized by the state.

2035: India builds orbital factory. The first low-sapient AI is created, with near-human intelligence. The South African Coalition (a loose economic alliance for sub-Saharan development) is formed. It gradually evolves into a strong regional power over the next six decades.

2036: Australia joins Korea-Japan mutual-defense treaty, creating the Pacific Rim Alliance. The Chinese space development corporation Xiao Chu is founded. In Canada, socio-economic stresses from the "loss of the west" led Québec and the Atlantic Provinces to gradually dissociate themselves from central Canada and negotiate membership in the European Union.

2037: The first asteroids arrive at the L4 point. They provide raw materials for habitat construction and space factories. First baby born on Luna. Russia establishes a colony on Mars.

2038: Tenzan Heavy Industry's manned plasma sail spacecraft *Phoenix* makes its maiden flight to the asteroid Ceres, inaugurating the "second age of sail." Its crew establish an outpost on Ceres, but the company abandon it a year later as uneconomical. Zarubayev regime begins a program aimed at eradicating the majority Kazak culture, language, and religion.

2039: A commercial D-He-3 reactor goes online in Japan. The Ares Conspiracy begins illicit terraforming of Mars. First quantum supercomputers are developed. A major application is the rapid solution of highly complex protein folding problems, a key to advanced biotechnology.

2040: Commercial fusion reactors go online in France, Germany, Korea, and Poland. Ares Conspiracy terraforming program in full swing on Mars. Biotech Euphrates and other firms begin offering human genetic upgrades on a custom basis; these are expensive, and often not fully successful.

TIMELINE: 2041-2050

2041: The Ares Conspiracy is discovered. Faced with arrest or worse, its members and sympathizers steal a NASA deep space vessel docked at Phobos, and flee to the asteroid belt. The city of Montréal secedes from Québec and becomes a free city.

2042: Ares Conspiracy exiles settle on the asteroid Ceres, occupying the abandoned Tenzan Heavy Industries mining base, which they rename Silas Duncan Station. Nanodynamics manufactures military microbot swarms for the U.S. Army. VeldtKorp, a division of Ithemba Biotechnologies, pioneers tissue-engineered "biomod organs" to provide transplantees with enhanced performance.

2043: Anglo-American expedition reaches Mercury; Elizabeth Daintith is the first human to set foot on it. Ares Conspiracy exiles on Ceres are joined by additional Martian sympathizers, swelling their population.

2044: Corporations Biotech Euphrates, Xiao Chu, and newcomer Colonial Genetics begin bioengineering plants and animals for a "new Mars." System Technologies AG takes the lead mining He-3 from the Lunar regolith to support the growing number of D-He-3 fusion plants on Earth.

2045: Regular shipments of Lunar He-3 begin reaching Earth. European Union places outpost on Mercury, to explore mining and solar power generation. First "universal" 3D printer appears.

2046: Religious leader Ali al-Rashid enters into an alliance with the Saudi monarchy, laying the ground for the Islamic Caliphate. First baby born in the asteroid belt (on Ceres). Reliable medical nanomachines are introduced.

2047: Nanodynamics markets the first virtual interface computer brain implants. Genemod insect farmers and bioweapons are developed by Ithemba Biotechnologies and VeldtKorp as low-cost alternatives to microbot swarms.

2048: Violence erupts on Mars between pro- and anti-terraforming partisans after China and the United States decide to halt efforts to reverse the Ares Plague. Anglo-German expedition reaches Venus. The Duncanite exiles begin a program to alter their descendants for long-term survival in microgravity.

2049: The centennial of the People's Republic of China is celebrated on Earth and Mars. Moderate Arab states led by Saudi Arabia establish the Islamic Caliphate. A multinational science mission lands on Jupiter's moon Europa. Ice-penetrating "cryobots" explore the subsurface ocean and discover primitive life.

2050: Biotech Euphrates markets standardized genetic upgrade gene sequences that enable parents to create children with guaranteed improvements in longevity, appearance, health, and mental stability.

THE COLONIZATION OF SPACE

"We choose to go to the moon in this decade and do the other things, not because they are easy but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win . . . This is in some measure an act of faith and vision, for we do not know what benefits await us . . . But space is there, and we are going to climb it."

– John F. Kennedy, Rice University, 1962

"We slipped and fell, and almost lost our nerve. Then we got up, and did the other things."

– Luu Sharon, professor of Earth history, University of Mars, 2100

The early 21st century saw an explosion of popular interest in space travel and colonization, thanks to advances in robotics technology. Missions to Mars, the moon, and the asteroids began to carry hundreds or thousands of tiny minirobots. Possessing one-way and two-way telepresence capabilities, they allowed paying customers – teletourists – to actually walk, crawl, hop, or drive across the surfaces of extraterrestrial worlds. Far from quenching a desire for a manned presence in space, interplanetary teletourism fanned its fires. Mars, the asteroid belt, and the deep beyond were no longer an impossible dream. They had become real: places not merely to explore, but to live.

RUST CHINA

The first American manned Mars mission was launched in 2024, preceded by unmanned supply rockets and robotic base-building. It ended in disaster in 2025. A software glitch caused a landing craft to collide with the main mission vehicle, the nuclear-powered *Horus I,* resulting in three deaths. The surviving astronauts were forced to take a long flight home. NASA's Mars program was crippled – but the Americans were not the only player in the game.

The People's Republic of China developed an increasingly active manned space program in the early 21st century. In the 2010s, China acquired a large chunk of the commercial heavy satellite launch market, as the last shards of Russian space industry collapsed. Their Mars program was to be the social glue that joined many Chinas into one, in the wake of the reunification with Taiwan and unrest in the far western provinces. It would not, immediately, pay for itself, but would build to a sustainable level, with the hope of eventual economic benefit from such activities as mining deuterium and sale of real estate. Spinoffs from the effort were thought to give China the capability to match American aerospace power, should the western giant interfere with China's growing hegemony in the Pacific. Beijing's professed goal was a self-sustaining Mars settlement by 2049, the 100th anniversary of the Revolution.

Taking a leaf from early American "Mars Direct" concepts, China fired off a series of *Long March VI* heavy-lift boosters from Earth, throwing equipment, hydrogen fuel, water processors, and small groups of taikonauts onto the red planet. The first launch was the *Chaosheng* ("Pilgrimage") mission, which reached Mars in 2026. Over the next 10 years, China launched

TIMELINE: 2051-2060

2051: Red Sword anti-government insurgency begins in Peru. Vosper-Babbage builds *Solaris,* the first fusion drive spacecraft. The first of many giant arcologies is constructed in South China

2052: Concerned by the threat that Peruvian instability poses to the space launch facilities at Quito, the United States joins Chile and Brazil in providing military aid to the Peruvian government. European Mercury base begins export of heavy metals. Nanodynamics develops sensory-link brain implants and software that allow one person to share another's senses, surface thoughts, and even dreams. "Slinky" experiences become a new mass media.

2053: U.S. ground troops are committed to the escalating Andes War in Peru. Civil war in Iran sees return of a secular state. Duncanites begin rapidly expanding their population using exowombs.

2054: Treaty of Jerusalem settles most outstanding disputes between Israel and its neighbors. In the Andes War, the U.S. use of orbital weapons and teletroopers to fight "by remote control" (while Peruvians on both sides die) shakes the morale of guerrillas *and* government forces.

2055: Peruvian government forces collapse. Red Sword insurgents take Lima as U.S. withdraws. The European Union builds Research Station Aphrodite on Venus; it is soon nicknamed "the Hell Hole."

2056: The Genetic Regulatory Agency is established in the European Union to police abuses of human HuGE technology. An infosocialist party is formed in Thailand, inspired by the theories of Kyle Porters. Russia faces a separatist movement in Siberia, the start of a string of nasty, low-intensity insurgencies around its periphery that consume its attention over the next decade.

2057: First fusion-drive spacecraft begin carrying colonists to Mars. The "second age of sail" comes to an end. Xiao Chu and Biotech Euphrates design the first Mars-adapted parahumans. 2057 is the "International Astrophysical Year." *Centre de Recherche AstroBiologique d'Europa* (CRABE) research base is established on Europa. United States Astrographical Survey (USAGS) is formed and takes over NASA's responsibility for planetary exploration. First baby born on Mercury.

2058: Zarubayev regime intervenes in ongoing Russian conflict, providing support for Russia. The first successful microgravity-adapted Duncanite parahumans are born, nicknamed *Tennin* (heavenly people).

2059: Dr. Arifa Ali develops a Grand Unified Theory that successfully reconciles gravity and quantum mechanics. China builds the Taiko Station spaceport in Earth orbit.

2060: Fusion power fuelled by Lunar He-3 now provides 5% of all Earth's energy needs and half of offworld energy requirements. As part of the renewed terraforming program, teams of Martian and (later) Duncanite space workers go to the distant Kuiper Belt. These "comet herders" begin installing fusion engines on icy Kuiper Belt objects and directing them toward Mars.

TIMELINE: 2061-2070

2061: "Fauxflesh," vat-grown meat, goes on sale, after a decade-long battle with safety regulators and the ranching industry. Similar products are artificial hides, horn, and fur and vat-grown wood and pulp. Dr. Raymond Garcia founds the Christian hyperevolutionist movement.

2062: Infosocialists win election in Thailand, the first of several info- or nanosocialist parties to achieve power in the 2060s and 2070s. Transhumanist movement pioneers "accelerated learning" techniques based on virtual reality immersion, memory-enhancing drugs, and brain implants.

2063: Vosper-Babbage establishes Aletheia Station asteroid base in the Main Belt. Nanodynamics begins development of cellular regeneration technology. Microbot toothpaste introduced

2064: Neglected by the Moscow government, Russia's small Mars colony declares unilateral independence, the first Earth colony to do so. The first baby is born on Venus. USAGS sends a manned mission to Saturn's moon Titan. Wealthy Christian hyperevolutionists purchase a second-hand space station in Lagrange 5 and found Seventh Heaven, one of the first "junk jungle" L5 habitats.

2065: Duncanites fracture into two factions: Green Duncanites, who remain centered in the main belt, and create Avatar Klusterkorp to market *Tennin* biotechnology to finance future pantropy projects, and so-called Red Duncanites, who leave Silas Duncan Station and settle in the Greek Trojans near Jupiter, with their main homes at Diomedes (Liang Mountain) and Agamemnon (Freehaven).

2066: LOGOS, the first sapient AI, is created. Valles Marineris on Mars is flooded. Chinese cybershells explore Pluto.

2067: Chinese cybershell mission continues to explore Pluto. Biotech Euphrates' offworld division create the first bioroids. They are living beings functionally similar to humans, but assembled using tissue engineering and "biogenesis" nanotechnology, and educated using accelerated learning techniques. Some are "bioshells" with decereberate brains housing puppet implants, while others are designed with intelligence up to or exceeding that of a human.

2068: On Luna, Shackleton Station becomes a free city. Nanostasis, a form of suspended animation, is developed by Xiao Chu researchers. *Posthuman Consumer Review* begins publication. Zarubayev earns nickname "Stalinaskha" due to his bionic implants and ruthless suppression of dissent.

2069: Lunar business interests complete Islandia, the first true O'Neill colony, located at L4. Australia and Indonesia rattle sabers over the autonomy of ex-Indonesian microstates. SpaTek builds a resort on Luna. Biotech Euphrates markets biogenesis nanotechnology and customized bioroid designs to orbital corporations who want to create a "made to order" workforce on site.

2070: U.S. President Crystal Lee Robinson announces the NAGHI project to settle Titan and mine helium-3 from the atmosphere of Saturn. Nanodynamics begins marketing cheap cellular repair nanosymbionts to spacers as an anti-radiation treatment. Xiao Chu creates bioroids optimized for Mars colonization. The nomadic, nanarchist Gypsy Angels Collective begins to coalesce from a loose coalition of Duncanite freehauler and comet-herder families.

dozens of rockets carrying people and supplies to Mars. The "China Express" also transported paying passengers from other nations. Nor was China alone: the United States got its act together, and their *Thunder Bird* nuclear-powered mission arrived safely in 2027, supported by many follow-up missions.

As the human presence on Mars grew, national missions were followed by corporate enterprise. In partnership with Japan's Tenzan Heavy Industries, China Aerospace established a number of Mars-Earth cyclers, spacecraft in permanent orbits that traveled between near-Earth and near-Mars space. These began carrying as many as a hundred visitors per trip – colonists, here to stay.

TIMELINE: 2071-2080

2071: System Technologies AG establishes Exogenesis research station on the asteroid Vesta in the Main Belt. U.S. Astrographical Survey sends probe to Neptune's moon Triton in consort with commercial teletourism company.

2072: GenTech Pacifica, an Australian-based transnational, begins the construction of the first large aquatic habitat, *Elandra.* GenTech makes extensive use of uplifted sea life and parahumans. Humans arrive at Huygens Station, establishing first permanent settlement on Titan.

2073: Xiao Chu and other Chinese biotech firms complain that unlicensed clones of their pharm animals are being pirated by Indonesian and Thai companies, and demand action. China threatens sanctions. U.S. Army inducts its first bioroid soldiers. First "cyberdemocracy" (p. 89) system enacted, in Switzerland.

2074: Indonesia, Peru, Thailand, and Vietnam establish the Transpacific Socialist Alliance (TSA) and release statement of principles. Reference to open access to nanotechnology leads to them being dubbed "nanosocialist" by the media. The Blue Shadow preservationist group founded, dedicated to fighting the "biocybernetic enslavement" of sea life. India's Mawari Digital media conglomerate is created. Russia establishes mining colony on Mercury.

2075: Ziusudra-series "ideal parahuman" genetic sequence becomes the first transgenic design to achieve widespread popularity on Earth. Chinese police begin investigation of Triad crime syndicate operations on Mars. Consumption of vat-grown fauxflesh exceeds that of "natural" meat in Europe, and approaches it in many other developed nations.

2076: Titan Consortium begins building Cassini Station and Huygens Base. Exogenesis researcher Gilbert Stokes is the first human to have his mind emulated, or "uploaded," in software. Founding of the TSA's secret Bioweapons Directorate, which investigates nanovirus weaponry. Term "infomorph" becomes popular, referring to any digital mind, AI, or emulation.

2077: China, the European Union, the Pacific Rim Alliance, and the United States all impose limited trade sanctions against the TSA. Most other nations follow suit within two years. In Europe, the transgenic calf Ermintrude is a spokesperson for the growing movement demanding an end to the raising of animals for food. Construction of the space elevator begins on Mars.

2078: The sapient artificial intelligence LOGOS publishes its revolutionary study of memetic theory, *The Propagation of Human Ideas.* Conclusive evidence of long-extinct microorganisms is found near Hellas on Mars. This leads to renewed recriminations against the Chinese-led terraforming process, which many Preservationists claim may have destroyed the last remnants of any actual life.

2079: Space carrier Mars Interplanetary starts replacing human crews with bioroids, igniting a lengthy labor dispute. Pan-Sapients Rights activists arrested in Los Angeles for attempting to "liberate" a sapient AI.

2080: Transhumanist Kazuhiro Nishimori is the first healthy human to undergo destructive uploading. Antimatter production begins on Mercury. The Aegis Project begins: an attempt to repair Earth's ozone layer. Avatar Klusterkorp sells *Tennin* genetic sequences to Xiao Chu and Tenzan Heavy Industries. European Union investigation into troubled Das Luftschloss L4 factory complex uncovers mistreatment of bioroid spaceworkers. Genefixed people now represent a majority of Earth's 11 billion people.

TIMELINE: 2081-2090

2081: The first Titan Consortium He-3 tankers reach their Lagrange 4 collection point. European Union passes laws that will phase out the raising of meat animals in favor of fauxflesh. The ghost of Kazuhiro Nishimori is first posthuman to visit Triton, his consciousness transmitted via laser communicator to a cybershell there. Green Duncanites sponsored by Avatar Klusterkorp begin secretly seeding Europa's oceans with altered life forms.

2082: The National Alliance, an anti-nanosocialist coalition, seizes power in India. Islamic Caliphate extends civil rights to sapient AI. Telepresence Experience Network (p. 95) is founded. First human born on Titan. Unusual Kuiper Belt Object 112434 Shezbeth is discovered. European Parliament's *Report of the Temporary Committee on the Situation of Biological Androids* condemns the bioroid industry. Biotech Euphrates and Xiao Chu dispute the findings, but halt production of controversial models and add new regulations.

2083: China demands that the TSA allow inspection of nanoweapons facilities. Incidents occur between TSA submarines and Chinese arsenal ships. PLA troops exercise near the Vietnamese border. The United States embargoes He-3 shipments to China and the TSA. Martian Space Elevator is completed.

2084: Near Saturn, Gypsy Angels Collective migrant workers occupy U.S. Astrophysical Survey base at Hyperion, then intercept an American He-3 shipment to sell to Rust China. China launches a surprise attack against Thai Bioweapons Directorate facilities and satellites. The other TSA nations honor mutual-defense treaty obligations, and the Pacific War begins, as TSA forces fight back in space and fire cruise missiles against Chinese ports and naval vessels. In deep space, TSA vessels launch multiple autonomous kill vehicles (AKVs) at Chinese targets. China destroys most of the TSA's orbital and surface space facilities, including their solar power satellites.

2085: A construction accident at Shackleton Station on Luna kills hundreds and forces the city's evacuation. Fierce fighting rages on the Chinese-Vietnamese border, but a royalist coup topples Thailand's hard-line nanosocialist government, and the TSA agrees to a European Union-mediated peace. Some Bioweapons Directorate personnel flee Earth. U.S. task force evicts "helium pirates" from Hyperion and establishes bases on Titan and Rhea.

2086: United States ends the He-3 embargo. Exogenesis places a robot factory on Io. Nicaragua becomes a nanosocialist nation. The ghost of Exogenesis engineer Susie Xu is the first posthuman to enter Jupiter, her body the cybershell probe *Not in Kansas.*

> **To go places and do things that have never been done before – that's what dying is all about.**
>
> **– Susan Xu**

2087: Remaining TSA powers, now led by Indonesia, meet in Lima, Peru, and renew their "peaceful commitment to nanosocialism and the ideals of Kyle Porters." Solar Express space courier service founded. Martian Triads begin manufacture of pleasure bioroids. First "xox cult" appears, in which followers are monitored and advised by a low-res mind emulation ("shadow") of its leader.

2088: The first cellular rejuvenation treatments are successful, using radical nanosurgery to restore the aged to vigorous health. The fastliner *Empress of Helium* is destroyed by rogue AKVs left orphaned by the Pacific War. It is the first of several victims. Red Duncanites at Liang Mountain install old-style deuterium-lithium-tritium fusion reactors to avoid dependency on imported He-3.

2089: A "crime war" between rival Triad factions on Mars secures the independence of the Martian Triads from Earth-based crime lords. Biotech Euphrates is contracted to *grow* a new Luna City using nanotechnology. Islandia space colony bans the ownership or indenture of bioroids.

2090: Nanodynamics establishes an ice-mining base on Jupiter's moon Callisto. Coup attempt against Zarubayev regime leads to a ruthless purge ("the Silence"). Many massacres are carried out by bioroid soldiers.

TIMELINE: 2091-2098

2091: Xoxing (making *multiple* self-aware mind emulations of a person) is made a felony in China. Similar laws are soon passed elsewhere. Muldoon expedition reaches KBO 112434 Shezbeth and discovers a primordial black hole inside it. European Union courts determine that sapient bioroids and infomorphs are "persons" under the law, resulting in an outright ban on bioroid manufacture and ownership in the European Union.

2092: FBI-Interpol investigation of the source of "brain bug" 3D printer programs are traced to the Greek Trojans, which are gaining a reputation as a marketplace for black market technology. The term "Trojan Mafia" is coined. Hawking Industries founded to exploit Shezbeth mini black hole.

2093: Work begins on the Olympus Project, an Earth space elevator designed to touch ground in Kenya. Hawking Industries team installs a high-impulse fusion torch drive on 112434 Shezbeth, and begins accelerating it toward their headquarters in the Main Belt.

2094: Rust China police barely prevent Negative Growth terrorists from destroying the Mars space elevator with a nuclear device.

2095: Martian Triads expand their operations into the Main Belt. Xiao Chu launches expedition to Oort cloud in quest of mini black holes. Space crews of Triplanetary Lines and Solar Express unionize, forming the Farhauler's Guild. Mars Interplanetary successfully resists unionization by employing (or threatening to employ) bioroid crews.

2096: Astrobiologists studying Europa stumble upon pantropic life forms, exposing the Europa Project's existence. It is denounced by preservationists as a clear and present danger to the Europan ecology. Seventh Heaven founds New Covenant asteroid colony on 511 Davida.

2097: 76 people in Shaoxing, China are forcibly uploaded by a rogue "emergent intelligence." Exogenesis builds the first bush robot. Chinese agents trace tritium used in Negative Growth nuclear bomb to the Trojan Mafia. PLA Navy Space Force mounts a punitive strike against Liang Mountain using space dominance vehicles. Red Duncanite "privateers" harass Chinese spacecraft. As Shezbeth passes Jupiter, a Red Duncanite privateer attempts to board her, dubbed a "blackjacking" by the media.

2098: European Union begins using military force to suppress "bioroid slavery" in areas without national government. Preservationist radicals calling themselves the Europa Defense Force arrive on Europa, and launch attacks against the Avatar Klusterkorp operations there. The "War Under the Ice" begins. French Foreign Legion commandos raid a bioroid factory in L5.

CURRENT EVENTS: 2099-2100

January 2099: Eugenics Liberation Front terrorists threaten to unleash Lucifer Plague nanovirus in Istanbul, causing mass panic. Anti-Zarubayev revolt in Kazakstan is crushed by bioroid and cybershell troops.

February: Xiao Chu builds Jiangli base on Titan. European Union authorities determine that many bioroid factories in L5 have moved to the Main Belt. After a month of heavy fighting, Kazakstan rebels retreat to sanctuaries in neighboring Uzbekistan, but continue to launch guerrilla raids.

March: Genetic Regulatory Agency investigation links bioroid trafficking to Martian Triad-controlled gas stations in the asteroid belt. Royal Navy Space Service sends a squadron to the belt to suppress the activity.

April: Xiao Chu officials accuse the U.S. military of planting microbot spies in Jiangli, and harassing them with low-level reconnaissance flights.

May: Zarubayev regime in Kazakstan launches assault on rebel sanctuaries in Uzbekistan, seizing control of a transborder "security zone." Rumors emerge that some government anti-guerrilla units are "special forces" composed of former rebels now controlled by puppet implants.

June: The utility space vehicle *Charlevoix* is destroyed in the Greek Trojans, apparently by another orphaned AKV from the Pacific War.

July: System Technologies AG sells Exogenesis to Nanodynamics for $16.7 billion.

August: A property rights dispute between Nanodynamics management and former Exogenesis employees and infomorphs results in a tense standoff at Exogenesis Station on Vesta.

September: Slinky superstar Xu Fang Shan is kidnapped and xoxed while vacationing in Spain. Black market mind emulations of her are sold throughout the system.

October: Executive Decisions Inc. mercenaries under contract to Nanodynamics seize Exogenesis Station. Several ex-Exogenesis spacecraft scatter into the asteroid belt. Fighting is reported at Exogenesis bases elsewhere in the system.

November: Royal Navy raids Martian Triad bioroid factory at Morrigan's Rock. Journalist Copernicus Jones escapes Europa Defense Force captivity. His testimony and recorded slinky experiences concerning the "War Under the Ice" are broadcast on Telepresence Experience Network.

December: Xiao Chu's Titan base minifactures a garrison of combat cybershells and bioroids, and demands USAF reconnaissance flights cease immediately. Infomorphs at Vostok Station in Antarctica report their humans are showing symptoms of massive nanovirus infection, then go offline.

January 1, 2100 is the current date of ***Transhuman Space.***

MINING THE MOON

Mars caught the imagination of China and America, but it was far from the only concern of the mid-21st century. In the 2020s and 2030s, the expanding world demand for energy had almost exhausted the accessible reserves of petroleum. Oil and natural gas were running out, but in many countries environmental concerns prevented the construction of new coal or nuclear fission plants. The solution proved to be fusion power, which bore fruit after decades of development. The first successful reactor program was led by a consortium of European and Japanese business and national interests. The U.S. government opted out, preferring to leave it to the private sector – which balked at the high start-up costs.

"First generation" prototype fusion reactors fueled by deuterium and tritium (isotopes of hydrogen) became operational in the 2030s. They were cheap to fuel, with deuterium being refined at modest expense from sea water, and the rare isotope tritium being "bred" by jacketing the reactor with lithium. However, much of the D-T reactor's output was in the form of neutron radiation. Less radiation was produced than a fission reactor, but D-T reactors proved to be politically unacceptable, as well as complex, expensive to run, and far too heavy for use in space. Nevertheless, they were a stepping stone to a "second generation" reactor. This used the deuterium-helium-3 reaction, which required a higher ignition point, and was thus more difficult to achieve.

The first of these new D-He-3 reactors was built at Tomakomai (Hokkaido, Japan) and went on line in 2039. Its energy was released in the form of charged particles, which could be easily harnessed for power. It was more compact, safer, and required less maintenance. There was only one catch: it had to be fueled not just with deuterium but also with the exceedingly rare isotope helium-3 (He-3), which was available only in minute quantities on Earth.

Fortunately, He-3 was far more abundant elsewhere. The solar wind had been blowing atoms of He-3 across the system for billions of years. Earth's atmosphere and magnetic field prevented these particles from reaching our planet's surface, but on airless Luna, eons of exposure had impregnated the moon's regolith (its "soil") with hundreds of thousands of tons of He-3. A single *pound* would allow a second-generation fusion reactor to produce 74 million kilowatt-hours of clean, safe energy. This made He-3 worth over a billion dollars a ton – a prospect that meant shipping it down from Luna was a viable option.

In the 2020s and 2030s, the availability of cheap nanofactured composites had given birth to a new generation of reusable space launchers. These craft – some powered by ground-based lasers, other by conventional rockets – drastically reduced the cost of shipping mass into orbit, from $10,000 a pound in 2001 to less than $500 in 2035. As a result, the now-decrepit International Space Station was joined by a growing cluster of manned and robotic space factories and labs. There was also a small unmanned permanent moon base, the Tsiolkovsky Farside Array, a multinational observation facility established by American, Chinese, Japanese, Indian, and European space agencies.

While Mars consumed the imaginations (and occasional lives) of Americans and Chinese, a number of visionary transnational companies saw that the infrastructure now existed for corporate development in translunar space. The money (and in Europe and Japan, the political will) was found. An alliance of aerospace and fusion power companies arrived on Luna with mining robots and human engineers. They established a pair of permanent lunar bases and went to work. Thousands of tons of Lunar regolith had to be excavated and baked to get even a few pounds of He-3, but the process also liberated vast quantities of oxygen and smaller amounts of nitrogen and carbon, useful for agriculture, rocket fuel, and manufacturing. By the 2050s, those nations and transnationals that had invested in Lunar mining turned the moon into a self-sustaining venture which paid immense dividends.

The expertise established to mine Luna paved the way for further exploitation of space resources. System Technologies A.G., Tenzan Heavy Industries, Vosper-Babbage, and other space industrial combines sent resource-retrieval missions to asteroids in Earth-crossing orbits. Initial sample-gathering expeditions were followed by more ambitious ventures. Mass driver propulsion systems changed the orbit of several near-Earth asteroids and maneuvered them into the Lagrange 4 and 5 points in Earth's neighborhood. They became the basis for clusters of work stations and habitats that, a half-century later, would be home to over a million people.

Fusion power, fueled by Luna, began to transform the Earth. Its most dramatic result was the cheap energy necessary to sustain existing industrial growth, to reclaim areas lost to creeping deserts by making desalination plants economically viable, and to halt the environmental degradation produced by the burning of fossil fuels. A more subtle result of fusion energy was to alter the balance of power between nations and corporations, raising up those who had chosen to cast their bread on the infinite waters of space.

THE ARES CONSPIRACY

In 2040, there were thousands of people living and working off Earth: a few hundred on Luna, several hundred more in various orbital and Lagrange-point stations, and a few dozen lonely souls on long-range asteroid survey and retrieval missions. The largest population was on the Red Planet: over 4,000 pioneers, more than half from China.

The first generation of Martians studied the planet's geology (or "areology"), grew plants in greenhouses, built underground habitats, tapped aquifers, tested new equipment, established model industrial parks, and entertained 10 billion people with the mid-21st-century version of reality television. They searched diligently for signs of past or present life. They did not find it . . . but Mars was a big planet, and some continued to hope.

The majority of the new Martians were scientists, engineers, and biotechnicians, but an increasing number had arrived not merely to study Mars, but to develop it. The most contentious issue facing Martian colonists and entrepreneurs (whether they came from Hong Kong, Taipei, Shanghai, or Houston) was the question of terraforming. Should Mars be transformed into another Earth? Or would that hopelessly prejudice the continued (if unsuccessful) search for Martian life and destroy a unique planetary environment?

The existence of multiple science bases on Mars, each with different agendas, hampered consensus. Public opinion in America, China, Japan, and Europe was torn between those who favored preserving the pristine Martian environment, in the hope of finding life, and those who saw the terraforming of Mars as opening a new frontier. American space advocates believed the "threat" of a "Red Mars" should spur a crash U.S. program to settle the planet, and that the only way to do that would be by promising to terraform the surface. In the middle stood China's political-economic elite, with an interest not so much in terraforming as in the transformation of Mars into a giant industrial park. As the centennial of the People's Republic loomed, visionary Chinese had begun to speak of Mars as "Rust China" – the new frontier for a new millennium, one that would eventually eclipse the thriving industrial cities of the south coast.

But in the end, it was not the Chinese or American government that called the shots on Mars, but the people living there. Two visions collided, and changed the destiny of mankind.

The Ares Conspiracy was a multinational cabal of Martian colonists, primarily genetic engineers and planetary scientists, who believed that terraforming would be forever mired in bureaucratic red tape and international wrangling. From 2039 to 2041, they planned and initiated terraforming techniques designed to trigger polar cap meltdown, including methane-producing bacteria, black, sun-absorbing lichen, and concealed robot-manufactured CFC factories in the wilderness. They had hoped to remain anonymous, but their activities proved impossible to hide. Some hailed them as visionaries. Others denounced them for an act of "planetary ecocide," referred to the lichen and bacteria as "the Ares Plague," and called for their arrest, deportation to Earth, and worse.

The result was a near-insurrection on Mars. As tension mounted, a way out was offered by Captain Latisha Fox, who commanded the NASA deep-space operations vehicle *Michael Collins,* in Mars orbit. Fifty-two of the conspirators chose to leave on the *Collins* rather than face arrest. Captain Fox's defiance of her superior officers, and her epic flight to the asteroid belt, in which overloaded life-support systems nearly led to disaster, is now a legend. The exiles were able to abscond with a substantial quantity of equipment, including state-of-the-art industrial robots and genetic-engineering gear meant for the Mars colony. They chose as their destination an unmanned Tenzan Heavy Industries outpost located on the asteroid Ceres in the Main Belt. They renamed it Silas Duncan Station, which Fox proclaimed "free of all government and gravity."

A New Mars

Outrage at the actions of the Ares Conspiracy led to the birth of the Preservationist Movement. Initially formed from activists who had opposed the use of nuclear reactors in space, they grew into a global coalition of environmentalists, planetary scientists, bioethicists, and astrobiologists who deplored the unilateral transformation of the Martian environment. Preservationists vowed to prevent further desecration of other planetary bodies. Their greatest success was pushing through the sixth protocol to the Revised Outer Space Treaty, which strictly prohibited terraforming other planets without international consensus. They would later expand their interests beyond the protection of planets to the protection of species genomes, including that of humanity. Preservationist ideology would ultimately lead to the creation of Europe's Genetic Regulatory Agency . . . but that was decades in the future. Now they looked upon what they saw as a ruined Mars, and wept.

Mars wept too: as the bacteria spread, temperatures rose, ice began to thaw, and advocates of terraforming rejoiced. China and America spent much of a decade in half-hearted studies of how best to reverse what the Ares bioengineers had wrought. Then they gave up. It was obvious that the Martian environment would, eventually, be hopelessly altered. Global public opinion had demonized the Ares Conspiracy as radicals, but a majority on Earth and Mars supported continuing the terraforming after the *fait accompli.*

The European Union had stayed out of the Mars controversy: most individual Europeans tended to support the Preservationist view, but Europe's space advocates were settling the moon, and sending missions to Mercury – where, everyone agreed, there was *no* likelihood of life. America's Martian passion, strongly felt, was also diverted: the nation was becoming tired of Mars scandals. The United States became embroiled in a nasty war in South America, and U.S. voters became more interested in watching Marine Corps teletrooper operations in the Andes than bacteria multiplying and ice melting on Mars.

Not so China. In 2056, Beijing announced an ambitious program aimed at further accelerating the terraforming of Mars, with the ultimate goal of human settlement. This decision was denounced by Preservationists worldwide, but in 2057, the fusion-powered heavy transport vehicle *Huayang* ("positive energy of the people") began shuttling large numbers of Chinese colonists to Mars. Built around the latest Euro-Japanese fusion reactor, the *Huayang* and her many sister ships were capable of ferrying colonists and supplies to Mars in under two months. Chinese colonization was backed up by a plan to divert ice asteroids from the Kuiper Belt and an ambitious program of *pantropy* (see p. 24) aimed at genetically engineering humans to the evolving Martian environment. Pantropic ideology also took hold on Ceres, where the exiled "Duncanite" genetic engineers of the Ares Conspiracy had begun to create their own new form of space-adapted human, the *"Tennin."*

NAHGI AND TITAN

The development of D-He-3 fusion had provided a safe, compact and theoretically inexhaustible energy source. Unfortunately, He-3 fuel was still very expensive. The moon's regolith held upwards of a million tons of He-3, but the extensive refining that was required limited the profitability of the operation. Moreover, although the reserves provided more energy than the world's entire supply (known and estimated) of fossil fuels, the planet's energy consumption was effectively doubling every 20 years.

No one was more aware of the high cost of fusion energy than the United States. The decision of America to opt-out of the aneutronic fusion power and lunar mining projects had not been entirely misguided. The cost of processing millions of tons of Lunar regolith for a few pounds of He-3 remained enormous, even when done largely by autonomous robots built on Luna. Nevertheless, the decision had its price: it left America's energy needs depending on rapidly waning fossil fuels and foreign He-3 imports. Attempts to establish a solar power consortium foundered on Preservationist protests against beaming microwaves into Earth's atmosphere. While some American firms had invested in Lunar He-3 mining, they could not afford to compete with the head start that System Technologies A.G. and its partners possessed. America needed another source of He-3, one that did not require the massive and expensive refining process that lunar regolith mining represented.

He-3 existed in a much purer state in the atmospheres of the gas giants Jupiter, Saturn, Uranus, and Neptune. Here for the taking were virtually unlimited quantities of the element – if it could be reached. The obstacles were formidable. Jupiter was the closest gas giant. Unfortunately, as the largest planet in the solar system, it had a deep gravity well which added a major penalty to any vessel attempting to skim its atmosphere and return with cargo. Moreover, Jupiter's magnetosphere created intense radiation belts that made any close approach hazardous, and its atmosphere was alive with terrible storms that made a terrestrial hurricane look like a child's sneeze. There was no way that a gas-mining operation could succeed. Neptune and Uranus were smaller and safer, but so distant that operations seemed economically unfeasible. That left one choice: ringed Saturn, the second-largest planet in the solar system, sixth from the sun. Its shallower gravity well and less-fierce radiation made it more attractive than Jupiter for helium miners willing to take the risk. It also offered a second prize: its planet-sized moon Titan, the only rocky world in the solar system besides Earth and Venus to have a dense atmosphere, albeit an unbreathable smog of nitrogen and methane. Titan's seas resembled an ice-cream-sundae version of the primordial soup that had spawned life on Earth. It was rich in industrial chemicals, and potentially more hospitable to life than Mars . . . save for its terrible -300°F cold.

Stung by Chinese and European successes in space, the American public had the will to embark on a new project. Thanks to successful robot exploration of Europa and Titan in the early 21st century, the American aerospace industry had experience near the gas giants. In 2070, the United States inaugurated the National Atmospheric Helium Gas Initiative (NAHGI), the largest government project since the end of World War II. Its goals were to free America (Brazil, parts of Canada, and Mexico opted in) from dependence on Lunar He-3 and foreign oil, and secure Saturn, "The Persian Gulf of the Solar System," as the source of America's (and the world's) energy needs for the foreseeable future.

NAHGI began with the construction of a robot outpost and factory on Titan. Known as Huygens Base, its purpose was to control, maintain, and (later) build drone scoop systems to mine helium-3 from Saturn and materials from the other Saturnian moons. It was managed by Titan Consortium, a coalition of government and industry dominated by two large corporations: Nanodynamics and Columbia Aerospace. The former oversaw the construction and operation of Huygens, while the latter developed the drone scoops and robot tankers which would operate from the newly built Cassini Station, a partner facility in close orbit around Saturn.

THIRD WAVE, FOURTH WAVE, FIFTH WAVE

The concept of "waves," first coined by Alvin Toffler, is a popular term for the techno-social complex that determines the nature of an entire civilization. In ***Transhuman Space,*** these are the *primary* technologies in each Wave:

First Wave – labor-intensive agriculture.
Second Wave – industrial manufacturing.
Third Wave – digital computers and networks.
Fourth Wave – genetic engineering and biotechnology.
Fifth Wave – artificial sapience and nanotechnology.

With the assistance of late-21st-century construction robots and experienced space workers (including a small Duncanite contingent), the two facilities were completed in 2080, a mere four years late and 52 billion dollars over budget – an amazing success. The following year, the first successful drone scoop test was completed, using a robot nuclear rocket to dive into Saturn's atmosphere and scoop up tons of gas giant atmosphere, retrieving more He-3 in a single day than System Technologies could process in a month. Seven months later, both Huygens Base and Cassini Station were fully operational. In 2081 the first of many Columbia-Nanodynamics robot gas tankers began boosting back to Earth-Lunar space. The price of fusion energy – and the influence of the Luna combines – was about to take a nosedive.

Gas tankers were heading Earthward, but the majority of the Titan Consortium's construction crews and administrators stayed behind. The original concept had been a largely automated station and transport operation plus a small manned scientific base, but unforeseen breakdowns and difficulties with Artificial Intelligence (AI) systems in NAHGI's early years resulted in a need to retain a larger than expected technical staff on Titan itself. Initial accommodations were Spartan (although salaries were high), and required a regular rotation of crews back to Martian or Earth-Lunar space. This was both disruptive and expensive, and so a decision was made to improve Huygens' habitability with the eventual goal of making it fully self-sufficient.

Almost by accident, America had established a permanent human colony in the outer system. Initially an adjunct to the He-3 business, the rest of the colony began to show considerable profit in the 2090s, when Titan began exporting nitrogen and other compounds (and later industrial and luxury agricultural products) to space habitats in the asteroids and outer system.

THE OVERTURN

The most dramatic contribution that NAHGI made was to space travel. The expansion of human settlement to the outer system made fusion drives more necessary. In the 2050s, only a few of the largest spacecraft had used fusion engines. The 2080s, with drive, reactor, and fuel prices falling, saw a revolution in the design of deep space vessels, as more and more fusion drive spacecraft were built. The result was a revolution comparable to the supplanting of sails by steam. The slow cyclers, fission drives, and plasma sails that had taken months to cross the solar system were rendered obsolete, replaced by the new "fasthaulers" that could manage the same trip in a matter of weeks. Only for crossing the vast distances to the outer edge of the system (such as missions to the Kuiper Belt and beyond) would travel times still be measured in years and decades.

With travel increasingly convenient, hundreds of thousands of people began to emigrate beyond Earth-Lunar space. China developed the immense *Zhongguang* class of heavy space transport vehicles, capable of carrying 5,000 colonists (frozen in nanostasis) per voyage. The first Solar Express fastliners were developed, carrying time-vital packages, business travelers, and tourists. A trip to Mars or Titan became no stranger than a transatlantic steamship journey at the dawn of the 20th century. The first private interplanetary spacecraft, the Executive Space Vehicles, began to appear. Designed to transport officials and diplomats to business meetings – light-speed lag made face-to-face vital – an ESV also became a coveted status symbol for the system's billionaires and transnational executives.

New Memes

Space was not the only place experiencing radical change. The 2060s and 2070s were a period of turbulence on Earth as well. Nations were both growing into larger alliances and fragmenting internally. States and provinces within nations broke into smaller units, leading to a limited return of the old "free city" concept. As longevity ended the concept of "retirement," the younger generation sought new forms of political power aimed at breaking the stranglehold of patronage and connections. A new, profound understanding of the way that ideas propagated through individuals and society – memetic theory – allowed politicians, social activists, and religious leaders to package and deliver their messages as never before.

> **Just as genes propagate themselves in the gene pool by leaping from body to body via sperms or eggs, so memes propagate themselves in the meme pool by leaping from brain to brain . . .**
> **– Richard Dawkins**

TSA: A New Power

"The transnationals create a false scarcity economy, placing barcodes and v-tags on everything from minifacturing software to genomes, claiming copyright on our common heritage of prosperity. We expose the real world, the world of abundance, as we strive to assemble a nonpolluting molecular socioeconomic system. They brand us criminals, but we are reality hackers, and we see the singularity forming. So can they! As we embrace inevitable transformation into an unknowable sphere of posthuman consciousness, we must be on guard to prevent the corruption of our destiny into nothing more than a frozen hyperemulation of the present. We seek a just transcendence! Information must be free before we can become information!"

– Infosocialist activist Pradhana Na Songkla,
at the Global Conference for
Economic Displacement,
telepresence from Bangkok/Thailand, 2081

In the 2040s, the socioeconomic philosophy of *infosocialism* began to gain adherents world wide. A nationalization of the idea that "information wants to be free," infosocialism failed to make much political headway in the highly developed nations. However, in the 2050s, a new incarnation of infosocialism – popularized under the name "nanosocialism" – gained adherents in Thailand and Indonesia, and later Peru and Vietnam, and also made strong headway in other countries. Friction occurred between nanosocialist countries and other nations over their radically different treatment of intellectual property rights and perceived willingness to tolerate piracy of genetics, software, nanomachines, and other technologies. Trade sanctions against nanosocialist nations led to a siege mentality, resulting in the formation of a tight bloc of countries with nanosocialist governments: the Transpacific Socialist Alliance, or TSA.

A variety of issues, chiefly Australia's actions to promote the formation of breakaway Indonesian microstates and the growth of Chinese naval power following its absorption of Taiwan, led the TSA powers into a series of confrontations with their Asia-Pacific neighbors. TSA nations Thailand and Indonesia began developing and acquiring bionanotechnological weapons, to counterbalance Chinese numbers and Australian-Japanese technology, as well as building up their own space assets. The TSA refused to confirm the existence of their nanovirus program, and a series of diplomatic confrontations led by China (who demanded international inspection) did not produce the desired result.

THE PACIFIC WAR

In 2084, Chinese intelligence discovered the location of the Thai-led nanovirus program, the TSA Bioweapons Directorate. Acting "in the interest of global peace and nanotechnological nonproliferation," China launched a strike on the facility using kinetic-kill orbital weapon clusters. However, Beijing had underestimated TSA resolve, and the "surgical strike" triggered full-scale war.

The Pacific War was characterized by information war, special forces, submarine and orbital space actions, but (except for fierce ground fighting on the China-Vietnam border), relatively low civilian casualties. A large part of this was the result of other nations actively using their own space defense platforms and ground-based laser weapons to intercept and destroy stray missiles. Nuclear weapons were not used, but some targeted nanobio weapons were released, with effects that persisted beyond the conflict.

The United States enacted sanctions against both China and the TSA, of which the most severe was an energy blockade that cut off supplies of He-3. The measures had an impact on China's Martian colonies, but an even more severe effect on the TSA, since their solar power network had been crippled in the first hour of the orbital battle. Most of the TSA's space weapons were destroyed by superior Chinese forces, but the TSA's aging stock of second-hand French-made Autonomous Kill Vehicles had been upgraded with new infomorph software, and these fought on even after their command centers were destroyed. However, the war on the ground had turned in China's favor. Despite a limited use of nanovirus weapons by desperate TSA commanders, Chinese People's Liberation Army forces pushed deep into Thailand and Vietnam. As casualties mounted, the Thai government collapsed in an internal coup, and withdrew from the TSA. Vietnam sued for peace and Indonesia took up leadership of the bloc. In 2085, the war ended in an European Union-negotiated ceasefire.

The Pacific War shocked the world. Over 316,000 people died in the war (and more in its aftermath), and the economic damage ran to hundreds of billions of dollars. The People's Republic of China claimed victory: it had lost soldiers, ships, and space assets, but achieved its objective, and neither mainland China nor Taiwan suffered heavy attack. In contrast, Thailand and Vietnam had suffered severe losses in infrastructure, and the other TSA powers were not unscathed. However, they had also not been defeated: they denounced Chinese aggression, foreswore the excesses of the Bioweapons Directorate as the work of militarists in the now-purged Thai government, and began to rebuild. Nanosocialists worldwide condemned the Chinese as hegemonists and offered support – and aid – to the TSA. Others were not so sanguine: fearing both China and a resurgent TSA, the governments of Australia, Korea, and Japan strengthened existing ties within a formal structure known as the Pacific Rim Alliance.

THE SHEZBETH EXPEDITION

In 2082, infrared astronomer Dr. Shiyomi Muldoon, working at the TSA's Chantarang Space University, discovered an anomaly. 2082 VK8 was an asteroid-like body with an unusually high temperature for its location: the cold reaches of the Kuiper Belt, beyond the orbit of Neptune. Further study showed this object, later named 112434 Shezbeth, was a source of radioactivity. It was intriguing enough that Muldoon was able to get funds from the Thai government for an expedition. Then came the Pacific War, and in the confused orbital fighting, Chantarang was targeted by a Chinese particle beam.

Counting her blessings that she wasn't aboard at the time, Muldoon refused to give up. Though the discovery's association with the TSA was an obstacle to mainstream funding, she nevertheless managed to put together an unlikely coalition of backers. Her spacecraft was the antique deep space operations vehicle *Alan B. Shepard,* donated by eccentric billionaire David Mbengi; he'd planned to refurbish her as a yacht, but had never gotten around to it. A trio of Christian hyperevolutionist ministers from the Seventh Heaven L5 colony provided her with a crew of ghosts and sapient AIs (to save on life support). One corporate sponsor came through: the British aerospace company Vosper-Babbage lent her mining cybershells and donated her spacecraft's fuel.

Muldoon's expedition reached 112434 Shezbeth in 2091. Its rocky surface had odd fracture patterns, but due to its stable orbit it had remained largely untouched since the birth of the solar system. Instruments showed anomalous gamma radiation readings. Most of all, it appeared to mass roughly twice what its density would indicate. Muldoon was pleased: her theory was correct. The asteroid held a primordial black hole. Muldoon and her backers now owned an atom-sized remnant of the Big Bang. While the vast majority of such objects should have evaporated in a storm of Hawking radiation long ago, Muldoon believed the Shezbeth anomaly had extended its life span by feeding on the asteroid itself, taking in just enough matter to keep it from evaporating.

It was a priceless commodity, both as a scientific curiosity and for its potential utility in high-energy physics experiments. The partners formed a corporation, Hawking Industries, to exploit the hole. A scientific foundation was established to study it . . . and to look for others.

By 2100, six other mini-black holes have been detected, most in the more distant Oort Cloud. Governments, corporations, and would-be prospectors have raced to be the first to claim them, even as cosmologists debate the implications. Meanwhile, scientists continue to study the Shezbeth hole.

THE FIFTH WAVE

In the 2080s and 2090s, the economies of the hyperdeveloped nations (led by the European Union, but including the United States, Japan, most space colonies and parts of China) were booming, with GNPs several times greater than in 2001. Quantum computers, microbot labor, cheap fusion power, asteroid resources, space-based manufacturing, memetic education, and emergent nanotechnology resulted in unparalleled growth. Symbolizing this was China's Martian Space Elevator: a giant nanofactured elevator that linked planet and sky.

Earth was still the center of the solar system, with 11 billion people forming a compact information gestalt. The data-flow culture of the mother planet was something space could not match: speed-of-light lag meant that it was Earth and Earth orbit where ideas could propagate the most quickly, with Mars not far behind. Disturbingly to some, the pace of development was increasingly set by posthuman technologies: pantropic engineering, robotics, self-aware artificial intelligence. On Earth, and to a lesser extent Luna and Mars, powerful governments and nongovernmental forces acted to keep these in check, voluntarily accepting some restraints on technology, particularly self-aware AI. Still, many feared the idea of Singularity, a point at which development would spiral out of control, and humanity would change beyond recognition.

The reasonable man adapts himself to the world. The unreasonable man persists in trying to adapt the world to himself. It follows that all progress depends on the unreasonable man.
– George Bernard Shaw

Others felt differently. What the Lagrange colonies, the Belt, and the outer system promised was freedom: the ability to explore memes, morphologies, and technologies out of sight of those who wanted to regulate, manage, and control them. The Duncanite nonstates in the Main Belt and Trojan asteroids, the growing number of ideological habitats in the L5 cluster, the asteroid research stations of the transnationals – all their successes (such as NAHGI and the *Tennin* calcium hack) proved that an ever-smaller number of humans could use fusion power, robot factories, and nanotechnology to bring dreams to economic life without the permission or assistance of the teeming masses of Earth. Of course, not everyone wanted to change humanity. Many went to space to seek a second chance, to create their vision of a better world. What frightened people was that they might succeed, and bring those visions back to transform Earth.

THE TRANSFORMATION OF MANKIND

> ***"Homo sapiens** is a lifestyle choice."*
> *– Chance Mackintosh, transhumanist activist*

By 2100, biotechnology had been propelled into areas once considered radical by human nature and market forces. Everyone wanted to live longer and healthier, and improve the lot of their children, and in the 21st century, human genetic engineering gradually became able to grant both wishes. As ethics struggled to keep pace with desire, the rich funded radical biotechnology procedures, including somatic genetic engineering, to ensure their children were free of genetic diseases, and gene therapy, to reset the aging clock within their own cells.

The mass-market acceptance of biotech products in wealthy nations was initially hindered by fear of genetically modified organisms. Europe did not *need* GMO crops – but high-population nations like Bangladesh, China, and India did, and desperately so. Buying GMOs from multinational biotech firms initially, they soon developed a sophisticated genetic engineering industry of their own. This helped diffuse biotechnology expertise worldwide, with unpredictable consequences.

PANTROPY

If the driving force behind Earthside human genetic engineering (HuGE) was health care and longevity, the power behind offworld HuGE was pantropy, the adaptation of terrestrial life for extraterrestrial and harsh terrestrial environments. There were some ideological pantropists, such as the Green Duncanites of Silas Duncan Station, and many in the growing ranks of the transhumanist movement. Even some moderate preservationists supported HuGE as the lesser of two evils: modify man, but leave worlds or ecosystems intact. However, ideology was not the main force driving pantropy. Economics was. Pantropic modifications made humans and animals *tolerant* of extreme environments, saving vast sums of money.

An altered human could not survive long on a partly terraformed Mars without some degree of artificial protection; he certainly could not breathe vacuum. However, genetic engineering and bionanotechnology could produce muscles and bones that suffered less debilitation in microgravity, or a physiology more tolerant of sudden pressure loss, radiation exposure, or carbon-dioxide poisoning. In turn, this went a long way toward making colonists feel at home, and reduced the dependence on expensive life support and the high costs of multiply redundant safety systems. The so-called "calcium hack" that allowed Duncanite parahumans to survive in microgravity or zero-gee without bone degeneration was the most important of these modifications, drastically lowering construction costs of spacecraft and space stations. The same was true, to a greater or lesser extent, of other harsh environments. Pantropy lowered life support costs to the point where it was affordable and desirable to colonize space with humans (or near-humans) rather than machines.

Human Obsolescence and the Receding Singularity

Contrary to some predictions, sapient artificial intelligence has not yet superseded humanity. One reason is that Moore's Law (which predicted that computing power would double every year or two) failed in the 2020s. Computers continued to get better, but the growth curve flattened out. More important, progress in human-superior AI turned out to be very difficult. It was hard to figure out a way to *use* the theoretical computational ability of a machine to produce true superintelligence. Moreover, humans themselves were getting smarter. While highly intelligent AI exists, no one has yet achieved one that is an order of magnitude faster and smarter than a human who is assisted by the latest in brain implants, mind-enhancing drugs, and networked nonsapient AIs.

So far, the "singularity" imagined by author Vernor Vinge – a point where change occurs so rapidly that we cannot see or comprehend what lies beyond it – has yet to occur. However, as Fifth Wave technologies continue to mature, there is no telling when – or if – such a point may be reached.

Morphological Freedom

Life extension and pantropy together pushed the frontiers of HuGE outward. On Earth the tide of public opinion ebbed and flowed between revulsion, indignation, fascination, and toleration.

Standards change, and what was unthinkable in one generation becomes merely eccentric and finally unremarkable. In 2001, cloning a human was a scandal, sex change operations were still controversial, and for many people, the idea of prenatal genetic engineering to prevent diseases in children was blasphemy. In 2050, it was a scandal that national health plans did not provide for genefixing every newborn to wipe out hereditary diseases; elections were fought over how to pay for it. An average citizen of a well-off nation could go to a clinic and undergo nanomedicine treatments to live a longer, healthier life. If he was a millionaire, he could also go to Quito or Bangkok or Cape Town and clone a dead spouse, grow a dog that talked, or arrange for his child to be born with a strong tendency toward beauty, mental stability, and mathematical aptitude. By 2100, those procedures were routine – but if a person wanted to build a custom bioroid sex toy, or upload his mind into a spaceship, or to give birth to a baby dragon, he would need to visit one of the more permissive transhuman enclaves – many no longer located offshore, but offworld.

Since the turbulent 2050s, a supranational body, the Genetic Regulatory Agency, has exercised a degree of influence on Earth, especially in the European Union. There are still some illegal "black clinics" in certain parts of Earth, but by the dawn of the 22nd century, the cutting edge of illicit HuGE had already moved far offworld: to the orbital fringe, L5, and the Duncanite enclaves in the asteroids and Trojan points.

What Is Human?

In many eyes, the central question of the world of 2100 is the definition of humanity. Hundreds of modified human germlines and dozens of parahuman species now exist. There is intelligent software that seems to be self-aware; there are gengineered beasts with the knowledge of good and evil, not to mention voices and opposable thumbs. Is an intelligent computer program, a talking dog, or a self-aware bioroid a machine, a pet, a slave? Are they our children, or our future?

A conflict is brewing that may dwarf the 19th- and 20th-century struggles over slavery and apartheid. While past differences between the shades of human ethnicity is a matter of thoughtless prejudice, those between artificial constructs and humans are real and demonstrable. If a bioroid or artificial intelligence is *designed* to be the slight inferior of a human, is it wrong to treat it as subhuman? If it is a potential superior, should it be allowed the freedom to do as it pleases, even to reproduce? There are no easy answers.

CAMPAIGN THEMES

The primary themes of ***Transhuman Space*** are the colonization of space and the transformation of mankind. But what can adventurers do?

ADAM SMITH ON MARS

The characters are out to make money by starting a business, shipping cargo across the solar system, or whatever. They'll need to make risky deals to pay off loans, fight hostile takeovers, and worry that their machines (if *they* aren't the machines) know more about the business than they do. Do they take that sweet deal on a second-hand zero-gravity laboratory complex in Lagrange 5? Who gets sent up to decontaminate it? What if the competition is bought out by the Martian Triads and now wants to put them out of business?

BLACK OPS

The planet had avoided large-scale war between major powers since 1945 or so, but the Pacific War pulled the cork from the bottle. Suddenly a general war seems plausible again. The basic issues raised by nanosocialism haven't been resolved. The TSA powers are still around and haven't been forced to make drastic changes to their government – they are spoiling for a rematch. Corporate war, human against machine, may already be breaking out in the Deep Beyond. It's the agents' job to do something about this.

Either the characters work for a corporate or government intelligence agency, or they are freelance snoops. It is easiest if the PCs are all members of the same agency (excluding any double agents, of course!); however, in lonelier parts of the system, agents of friendly powers may find themselves cooperating against mutual enemies. Surveillance microbots, decryption, data mining, and satellites can provide vast quantities of information, but nothing compares to "turning" someone on the other side in order to have a mole in the enemy camp. Much special ops work is done with "sanitized" microbots and infomorphs carefully selected not to trace back to a particular origin. Thus, Chinese operatives may acquire German cybershells for a special op aimed at America's Columbia Aerospace corporation.

LAW AND ORDER

The characters fight criminals or erase outlaw entities. They may be local cops, a large agency such as the Genetic Regulatory Agency, or freelancers such as bounty hunters or xoxhunters. GMs may wish to mix individual episodic crimes with a "big picture" story involving the characters' struggle against a very powerful villain. They may not know who the spider in the web is, or they may know their enemy but have no evidence that can stand up in court.

A complication for cops is that just about everyone has a virtual interface. Not only is upstairs (often in the

form of an infomorph partner) looking over their shoulder, but witnesses and criminals are likely to be recording their actions – and uploading them onto the Web. GMs can complicate adventures with the need to follow proper procedures and testify in court, with pressure from "upstairs" to solve things quickly or get off a sensitive case, journalists getting under foot, citizens firing off complaints, crime lords with spies in the department or cops on the take, lawsuits for alleged brutality, offers of bribes, budget cuts, and interspecies relations (which now include parahumans, infomorphs, and others) on or off the force. What if the city wants to replace all the human or bioroid cops with sapient AIs?

MEME WARS

The characters are activists working to change society, or prevent someone else's changing it. Take one of the memes described in Chapter 3 (pp. 86-91) and create a group of heroes (or a villain) who strongly supports or opposes it.

For example, the PCs might be pan-sapient rights activists attempting to abolish the exploitation of infomorphs and bioroids, or they could be agents of the Algernon Foundation (p. 98), struggling to prevent the machines from taking over the world. Other possibilities include infosocialist radicals exposing the greed of transnational corporations, missionaries spreading their faith to the far corners of the solar system, cyberdemocrat activists fighting a corrupt political machine, or preservationists trying to save extraterrestrial environments. The opportunity for adventure is increased if the characters or their rivals choose to work outside the system. For example, the PCs might be the aides and bodyguards of an populist infosocialist political candidate, but if their opponents stoop to violence, it's hard to avoid trouble.

NATION BUILDING

Characters can take up the challenge of creating their own society. Their motives may be corporate or ideological in nature. Numerous challenges can arise, from personality and ideological clashes within the colony to "man against nature" adventures. Another possibility is to take over a failed arcology or space colony and make it work. What if someone else also wants to colonize the same real estate? Maybe the rivals (or the PCs) aren't even biological, but a group of infomorphs sent by a corporation to develop the same territory.

OUTLAWS

The characters exist beyond the law. They may be anything from a gang of streetwise biopunks in Quito or Jakarta to the best hit men for the Maple Syndicate or Martian Triads. They could be actively involved in an organized syndicate, freelance contractors, or even wanted fugitives on the run from the law or the mob. Perhaps when things got too hot on Earth, they headed into space, or vice versa. Their goals may be money, power, or simple survival, or they may have grown up in a crime family and be motivated by filial duty and tradition.

SOLDIERS

The campaign's focus is military operations. Unless a new major war has just broken out, affrays involving great powers will usually be limited affairs – see *Operations Other Than War,* p. 100. However, nasty civil wars and border disputes are simmering in many underdeveloped nations in Africa, Siberia, Central Asia, Micronesia, and Central America. Many of these are struggles between nanosocialist guerrillas and government regimes, or vice versa, but the fires of older conflicts may also remain hot. Insurgencies have also flared up in some parts of Fifth Wave countries like the United States, where cyberdemocrat radicals battle the federal or state governments. These small wars offer good employment for mercenaries, but they can be very grim affairs. While transnational corporations rarely conflict with one another, labor disputes and problems with local populations can sometimes take on a violent character. They call their troops "security forces" rather than "mercenary soldiers," but whether the mission is evicting squatters from an old L5 colony that's to be refurbished, repossessing rogue infomorphs, or protecting a deep-sea mining operation from Blue Shadow ecoguerrillas, there's plenty of opportunity to soldier for wealthy patrons in strange places.

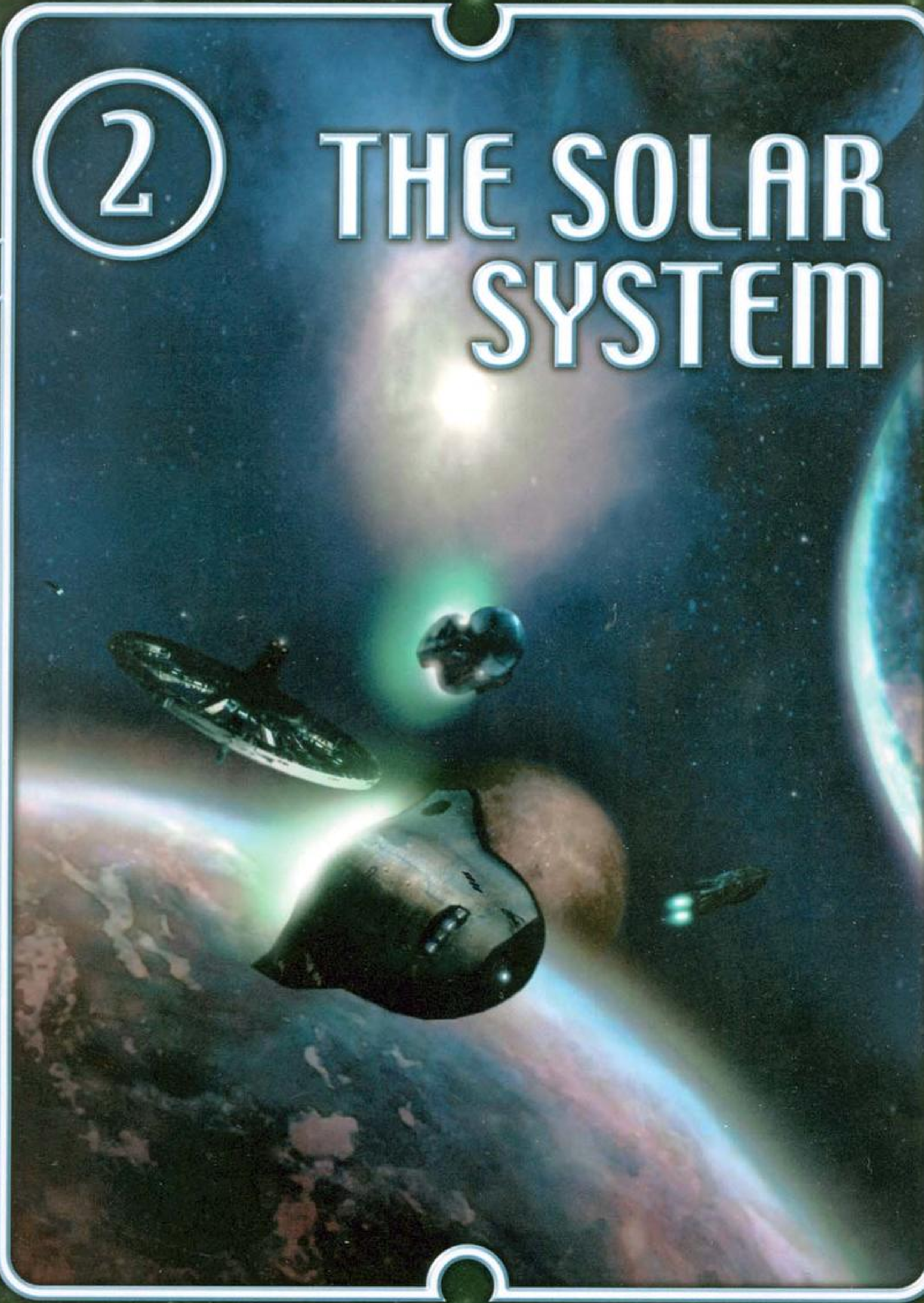
TRAVELERS

The goal of this campaign is to get the PCs to see as much of the universe as possible. A hero may be on a quest to find just about anything: a lost relative, his missing memories, or the one-armed bioroid who killed his father. To keep the adventure moving, some sort of push or pull is needed. This can involve a quest for information or an object, escorting someone or something, hunting an enemy, or just about anything else.

Characters need a reason to travel. Jobs like bounty hunting or freelance reporter give good reasons to be on the move. For example, suppose the PCs find evidence of a war crime in the Pacific War. They want to discover who was responsible and why it was covered up. Unfortunately, those involved have scattered across the solar system. Some may be dead, others transformed into digital ghosts, and so on. The trail is cold, but they have *one* clue . . .

2

THE SOLAR SYSTEM



> *"To step out onto the soil of asteroids, to lift with your hand a stone on the moon, to set up moving stations in ethereal space, and establish living rings around the Earth, the moon, the sun, to observe Mars from a distance of several tens of* **versts,** *to land on its satellites and even on the surface of Mars – what could be more extravagant! However, it is only with the advent of reactive vehicles that a new and great era in astronomy will begin . . . But I hope that my studies will if not soon but perhaps in the distant future, yield society mountains of grain and limitless power."*
>
> *– Konstantin Tsiolkovsky, 1912*

Our solar system is centered on the sun, a medium-sized yellow star. It is orbited by four sizable rocky bodies (the inner planets), four much larger gas giants, and numerous smaller rocky and icy bodies (asteroids and Kuiper Belt objects, including Pluto). Two inner planets, all the gas giants, and some asteroids and Kuiper Belt objects have rocky or icy satellites of their own.

Map of the Solar System

The map on p. 33 depicts the locations of the inner planets and two nearest gas giants, as well as some settled asteroids as of January, 2100. Their positions will change gradually over time. GMs interested in tracking this should use appropriate software (see *Bibliography,* p. 206). For a table of distances between each of these bodies, see *Interplanetary Distance Table,* p. 51.

INNER SYSTEM

The "inner system" refers to the area from the sun to the outer orbit of Mars. It is the most heavily populated region of the solar system.

Statistics: Explanations

This chapter provides statistics for significant planets and moons.

Diameter is the equatorial diameter.

Mass is self-explanatory.

Rotational Period: This is the sidereal day, the time it takes for a body to fully rotate around its axis. It is given in Earth days or hours. For Earth, this is one day.

Orbital Period: This is the sidereal year, the time it takes for a body to complete a full orbit around a central body, such as a planet around the sun. It is given in Earth days or years. For Earth, this is one year.

Solar Day: The time between local solar noon from one day to the next.

Density is the average density of the body in grams per cubic centimeter. Water has a density of 1 g/cm^3, so bodies with densities of 1.0-1.5 are more ice than rock, while those with lower densities are primarily composed of gas.

Escape Velocity is the velocity in miles per second (MPS) needed to escape the body's gravity and enter interplanetary space. *To Orbit* is the lesser velocity needed to go into orbit.

Atmosphere Pressure and Composition: The pressure (in Earth atmospheres on the surface) and density, and the gases making up the atmosphere. Atmospheres inside space habitats are similar to Earth unless noted.

Since gas giants such as Jupiter have no solid surface, the diameter and gravity given are at the 1 atmosphere pressure level.

Surface Water is the percentage of the planet or moon covered by liquid water. Subsurface water or ice deposits are also indicated.

Temperature is the annual average. It may vary by latitude, time of day, and season.

Moons are a planet's natural satellites, if any.

Population is the total number of biological sapient beings, excluding animals, AIs, etc., but including bioroids.

Spaceports are the name and extent of orbital and ground facilities.

Control Rating (CR) is a rough measure of the degree of government regulation (see p. B249).

THE SUN

The sun is a G2 yellow dwarf star. Its composition is 75% hydrogen and 25% helium, with traces of other elements. In its core, pressures of 250 billion atmospheres create the conditions for thermonuclear fusion. Each second, 700 million tons of hydrogen are converted to 695 million tons of helium, at temperatures of 27 billion degrees F, generating an output of 386 million trillion megawatts. Much of this energy is absorbed as it travels to the sun's surface. The photosphere – the sun's surface – is "only" 11,000°F, although the invisible corona extends out for millions of miles beyond the surface, and temperatures here can reach 3,000,000°F.

The sun radiates a stream of ionized matter, the *solar wind,* into space at velocities averaging about 280 miles per second. This outflow of solar plasma eventually encounters incoming charged particles from interstellar space; the boundary where this occurs is known as the *heliopause* and is one way to mark the "edge" of the solar system, approximately 150 AU from the sun.

The solar wind is not just of academic interest: its intensity varies unpredictably, sometimes flaring up dramatically. Its interactions with planetary magnetospheres can produce power surges or affect communications, while solar flares are a radiation hazard that requires spacecraft, stations, and surface colonies on worlds with thin or no atmospheres to have heavy radiation shielding. Like Earth's winds, the solar wind can also be used for propulsion and power. Spacecraft using plasma sails rely on it for propulsion, and its particles have seeded Mercury and Luna with the fusion reactor fuel He-3.

Statistics: The Sun

Diameter: 864,500 miles.
Mass: 332,946 Earths.
Density: 1.4 g/cm^3 (mean), 151 g/cm^3 (core).
Escape Velocity: 383 mps (miles per second).
To Orbit: 268 mps.
Orbital Spaceports: European Solar Observatory (with spacedock facilities).

Solar Flares

Solar flares are storms of high-energy protons emitted from the sun. The sun follows a rough 11-year cycle of flare activity, and during peak periods (the solar max) flares multiple flares may occur within a space of a few weeks.

A typical flare lasts several hours: solar observatories can give a few hours' warning.

On average, small flares occur 1-6 times each year and deliver 50-150 rads, mid-size flares every 2-5 years delivering 200-1,200 rads, and major ones a few times every decade (at the solar max) delivering 2,000-6,000 rads. These dosages are in space at a distance of 1 AU from the sun; divide by the square of the actual distance. Thus, someone 0.5 AU from the sun during a small 100-rad flare might take 100/0.25 = 400 rads. See *Radiation,* p. 59.

Someone on the surface of Earth, Venus, or Titan, and, to a lesser extent, Mars, is protected by miles of atmosphere, but anyone in space or on an airless body is exposed. Colonies on places like Mercury or Luna burrow underground, and large space stations are built with heavy and expensive shielding, while small stations and spacecraft have "storm shelters" that crews and passengers can retreat into. Flares also disrupt broadcast radio transmissions within the inner solar system, but laser communications are unaffected.

There are a few solar observatories located near the sun, whose functions include the study of solar phenomena and early warning of solar flares. Spacecraft on system-crossing trajectories sometimes dive close to the sun to obtain a boost from its gravity, but rarely stray too near the corona.

Some recent studies on solar neutrino production suggest one or more primordial black holes (p. 49) may be located near the center of the sun.

MERCURY

This planet is the closest to the sun. It is also the second-smallest planet, although its iron core makes it the densest body in the solar system after Earth. Mercury has practically no atmosphere. As a result, day-night temperature variations are extreme, ranging from -300°F in the shade to 800°F in the sun. Amazingly, water ice exists in the perpetual shadows of some polar craters. The combination of ice, abundant solar power, and mineral resources made Mercury an attractive location for colonization.

Mercury's surface is a mix of heavily cratered highlands and smoother lowlands. The Caloris event, 3.85 billion years ago, was a giant asteroid impact that blew off much of Mercury's surface crust. It created an 840-mile-wide crater halfway between the equator and north pole, marked by concentric blocks of mountains around its edges. The Caloris impact was so powerful that seismic waves carried through the planet, creating the Guido

Statistics: Mercury

Diameter: 3,032 miles.
Mass: 0.055 Earths.
Density: 5.4 g/cm^3.
Gravity: 0.37 G.
Escape Velocity: 2.7 mps.
To Orbit: 1.9 mps.
Rotational Period: 58.6 days.
Orbital Period: 88 days.
Solar Day: 176 days.
Atmosphere: Vacuum.
Surface Water: Trace polar ice.
Temperature: -280°F (shade) to 800°F (sun).
Moons: None.
Population: 110,000.
Control Rating: 4.
Spaceports: Large spaceport (at Goethe crater). Several small spaceports.

d'Arezzo, a zone of jumbled, mile-high hills and valleys the size of western Europe.

Both the impact basin and the Guido d'Arezzo are rich in heavy metals, although they are located far from the more habitable poles.

Mercury is blessed with rich deposits of heavy metals, as well as some He-3. The largest colony, at Goethe Crater on the north pole, was founded by a coalition of European Union governments and corporations. They have built a 100-mile-long mass driver to accelerate loads of metal to Earth-Lunar space, and established several mining bases across the Caloris Basin.

Four other nations also have mining colonies. Sharing the north pole are the United States (at Purcell crater), and Russia and Brazil (at Aristoxenies crater). On the south pole, China has a large facility at the ice-rich Chao Meng-Fu crater. Many of the inhabitants are contract workers rather than permanent immigrants; China, Brazil, and the United States also use bioroids.

The other major industry is the use of solar power to produce antimatter. The European, Chinese, and American antimatter factories (mostly built on the equator) use hundreds of square miles of solar cells to power large particle accelerator facilities that create antihydrogen at a rate of a few grams a week. The value of antimatter has resulted in institutional paranoia. Officials are alert for spies, security is tight, and any industrial accident is regarded as potential sabotage. All national bases have military garrisons.

Statistics: Venus

Diameter: 7,521 miles.
Mass: 0.815 Earths.
Density: 5.2 g/cm^3.
Gravity: 0.91 G.
Escape Velocity: 6.5 mps.
To Orbit: 4.6 mps.
Rotational Period: 243 days.
Orbital Period: 225 days.
Solar Day: 117 days.
Atmospheric Pressure: Superdense (90 atm.).
Atmospheric Composition: Carbon dioxide (96%), Nitrogen (4%).
Surface Water: None.
Temperature: 850°F.
Moons: None.
Population: 2,000.
Control Rating: 4.
Spaceports: Small spaceport at Research Station Aphrodite.

VENUS

Venus is a hellish pressure cooker of a planet, starkly hostile to life. The planet is almost as large as Earth, and similar in composition, but there the resemblance ends. Its rotation is slow and retrograde to Earth's, so the sun rises in the west and sets in the east. Venus has an atmosphere of superdense carbon dioxide, and its surface is completely shrouded in pale yellow clouds of sulfuric acid. Its proximity to the sun and dense cloud cover create an extreme greenhouse effect, resulting in temperatures hot enough to melt lead. The crushing pressures on the surface are equivalent to those half a mile beneath Earth's ocean. Daytime on Venus lasts for months, and is illuminated by dim, lemon-colored, omnidirectional light. The long nights are pitch black; the stars are never visible from the surface. Venus has two main "continents," the north-polar Ishtar and equatorial Aphrodite, each elevated miles above the surrounding terrain. There is no water. The surface is a gloomy, barren desert of basalt bedrock, sand dunes, fractured terrain, and old lava flows.

A few humans live and work on Venus, but their gear and habitats must be expensively engineered to withstand the extreme temperatures and pressure. The major base, Research Station Aphrodite, is run by Germany and the United Kingdom, with a transient population of 1,100. Its primary mission is to study Venus to discover information relevant to Earth's own evolution and to lay the groundwork for a long-term Venusian terraforming project (which will likely take centuries). Aphrodite maintains scientific outposts scattered across the planet and various facilities in orbit. Visiting scientists from other nations also rent space at Aphrodite for their own projects.

Most of Venus' human population are planetary scientists, terraforming engineers, and technicians. The latter call it "the Hell Hole," and spend their time maintaining or redesigning systems that degrade under the environmental stress. A few commercial ventures have also been attempted. Some prospectors have found diamonds; SpaTek corporation organizes cybershell teletours.

In 2094 a small TSA base was established on the other side of the planet. It may be a military research facility, but its precise purpose is unknown.

EARTH

The planet of blue skies, green fields, and vast cities, Earth is the only world where a normal human can breathe the open air or walk unprotected on its surface. Earth's 11 billion people represent the majority of the solar system's human population. Earth is at the leading edge of technological change, fashion, and innovation, and the center of civilization. The *average* global standard of living in 2100 is *six times* what it was in the year 2001. While the bulk of humanity is better off, discrepancies between rich and poor have increased to an unparalleled degree. Aging but vigorous populations make stable countries more so, but elsewhere, radicalism is on the rise, as new and virulent *memes* (pp. 86-91) struggle to displace older ideologies.

Ecology and Climate

The global ecosphere is still habitable, but it does require regular management. Fortunately, the worst excesses of 20th-century pollution are being reversed. However, global warming remains a problem. Greenhouse emissions from sources like fossil fuels are down, but human energy use is up: 13 times what it was in 2001. The world's sea levels have risen slightly, and while some regions are warmer, others suffer longer winters. The ozone layer is no longer declining, but has not recovered to 20th-century levels. It is dangerous to stay outdoors in direct sunlight, especially in high northern or southern latitudes.

This is also an era of "heavy weather." Fierce hurricanes, typhoons and tornadoes are roughly twice as common and twice as destructive as they once were. Weather control using powerful orbital lasers (to heat warm air masses) can sometimes redirect them, but with no world government, doing so is controversial, as no nation wants a storm redirected onto *them.* Many of the world's best AIs are kept busy predicting and controlling the climate.

The ecological damage wrought by these changes and the spread of human industrialization has driven many species to extinction. Even today, many plant and animal species are being displaced by hardier, human-engineered variants. Since the 2050s, cloning and genetic engineering has brought some dead species back, where intact DNA samples were preserved. People now keep samples of endangered plants and animals in nanostasis, but past losses are incalculable.

Statistics: Earth

Diameter: 7,928 miles.
Mass: 1 Earth mass.
Density: 5.52 g/cm^3.
Gravity: 1 G.
Escape Velocity: 7 mps.
To Orbit: 4.9 mps.
Rotational Period: 24 hours.
Orbital Period: 365 days.
Solar Day: 24 hours.
Atmospheric Pressure: Standard (1 atm.).
Atmospheric Composition: 78% nitrogen, 21% oxygen, 1% argon.
Surface Water: 71%.
Temperature: 45 to 100°F (average range).
Moons: Luna (0.0026 AU from Earth).
Population: 11 billion.
Control Rating: 0-6 (average 3).
Spaceports: Large spaceports include Quito (Ecuador), Sanya (Hainan Island, China), Cape Canaveral (USA), Kourou (French Guiana), and Sriharikota Island (India). Small spaceports include Baykonur (Kazakstan), Cape Town (South Africa), Pekanbaru (Indonesia), Plesetsk (Russia), Sargodha (Pakistan), Tanegashima (Japan), Woomera (Australia), Yavne (Israel), and others.

Nations

The nation-state remains the basic political unit, although a growing phenomenon is the rise of city-sized microstates with special status or autonomy.

Some countries have broken into smaller regions, others have changed their names, but the political map is not dissimilar to that of the 20th century. Most governments are representative democracies, though sometimes in name only. There is no world government. Global politics is dominated by great powers and regional alliances; the most influential are the European Union, China, the United States, the Pacific Rim Alliance (p. 82), and the Transpacific Socialist Alliance (p. 82).

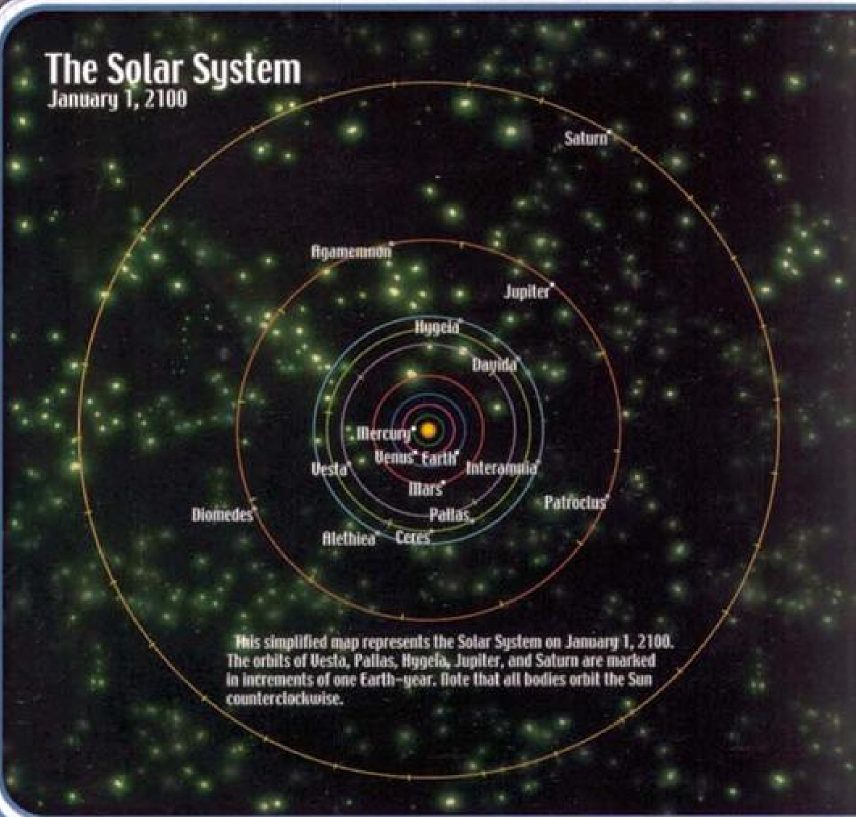
Urban and Rural Life

Mature global Web and telepresence technology has removed the need for people to be physically present in offices, schools, and factories. However, rising populations have pushed people together. The result is mixed: some urban centers have suffered neglect, as "community" no longer equates with "neighborhood," while in other locations, deliberate efforts have been made to reverse this. In the last 40 years, cheap cybershell labor has dramatically reduced the cost of construction, making massive urban renewal projects affordable. The most extreme examples are the replacement of entire cities with *arcologies,* giant cities-in-a-building that house tens of thousands of people, surrounded by parkland, farms, or the remnants of earlier cities.

The world's agricultural production largely comes from giant farms, with genemod crops tended by gengineered insects and microbots rather than humans or larger machines. In some areas, government subsidies or entrepreneurial spirit have kept smaller farms alive. Some specialize in exotic "pharm" animals and plants gengineered to produce unique pharmaceutical products. Others avoid genetic engineering to raise "organic" food for the sizable minority of consumers who still insist upon it. Subsistence agriculture also continues in a few poorer regions, with a mix of gene-hacked gray-market copies of pharm plants and animals plus old-style farming and herding.

Meat is grown in "fauxflesh" vatfacs using engineered cell cultures. Vast tracts of forest have returned to wilderness, as similar techniques vat-grow wood and pulp to order. Raising live animals for meat is looked upon much like hunting or trapping a century before. It's practiced by some as a recreation or lifestyle, disdained as barbaric by others, and banned in some nations.

The increase in wilderness, made possible by the decline of ranching and forestry, has been countered by a growing interest in living in such areas. The reduced need to physically commute to work (either due to telepresence or arcology living) has caused a decline in automobile use and a growing number of well-off communities far from civilization. Cheap minifacturing technologies (p. 69), air cars, global satellite communications, virtual-reality telepresence, and inexpensive solar power all make physical isolation palatable. Many such "telepresence communities" are gated communities that restrict membership and outside access to those with appropriate money or ideology. People seeking cheap land or genuine isolation head to more hostile areas such as the poles, deserts, or underwater. These areas are increasingly being settled by "econiche" parahumans designed for particular environments.



This simplified map represents the Solar System on January 1, 2100. The orbits of Vesta, Pallas, Hygeia, Jupiter, and Saturn are marked in increments of one Earth-year. Note that all bodies orbit the Sun counterclockwise.

Elandra

Pantropy and fusion power have also opened up the world's oceans. There are several underwater settlements, of which Elandra is the largest. Located in and under the Pacific Ocean, Elandra is a collection of aquatic habitats with a total population of 14,000. Much of Elandra's income comes from mining petroleum deposits and black smoker volcanic vents. Politically, Elandra is a free city within the Pacific Rim Alliance. Its large Australian population has resulted in its being nicknamed "Deepstralia," which most Elandrans dislike. Many of its inhabitants are aquaform parahumans and uplifted animals. Elandra's interests are closely aligned with those of the transnational GenTech Pacifica (pp. 94-95).

The Web

This global data-flow network was the foundation of Third Wave civilization, and in vastly more complex form exercises tremendous influence in the lives of nearly every human from Earth to Luna. Humans rarely "surf" the Web any more. It impinges on them through almost every waking moment as augmented reality (see p. 62), overlaid and transmitted through wearable or implanted "virtual interfaces." The actual site navigation and data mining is handled almost entirely by autonomous subprograms controlled by infomorph AIs. No one talks about "going online" – with cellular and satellite transmitters nearly everywhere, that's the normal state. Going "dead" – losing Web connectivity – is as rare as a power blackout, and just as annoying.

When people talk of visiting the Web, they mean one of the millions of virtual realms that exist. Using virtual interface modeling software, it's not hard to create "virtuality" content on a local or vast scale. A visitor can access these with proper hardware and a password.

There are millions of virtual communities, from small and exclusive locations to places as diverse and complex as a large city. In some, the user experiences the situation from a disembodied perspective, while others plug him into a specific avatar (for example, a dolphin in an undersea realm) or allow him to import his own choice of bodily imagery.

Virtual realms are rarely visited to perform simple activities better handled by autonomous agents, such as routine shopping or information searches. Some host elaborate interactive multi-user simulations or roleplaying games. Most are just places to socialize with other people: the 21st-century equivalent of a office boardroom, club, coffee shop, park, study, or mall. Many people have personal virtual rooms or houses (often started when they were children, and continually renovated since) which can be larger than their real residence. This is common for inhabitants of overpopulated urban areas in Third- and Fourth-Wave countries. The richness of virtual realms varies with the available computing power and storage space of their owners.

"Weblife" is a term for digital entities ("infomorphs") whose attention focuses primarily on the Web. Uploaded human personalities and wholly artificial intelligences can both be considered weblife. Those virtual realms which are frequented mainly by weblife are often exceedingly bizarre by human standards.

EARTH ORBIT

Earth orbit is one of the busiest locations in the solar system. It is divided into three major zones:

Low Earth Orbit (LEO) is the crowded region from the top of the atmosphere to the bottom of the Van Allen radiation belt a few thousand miles up. It is easy to launch satellites into LEO, and they rapidly orbit the Earth, but they can only see a small portion of it at any given time.

High Earth Orbit (HEO) runs from just above the inner Van Allen belt (about 3,000 miles up) to 22,000 miles up. It gives a good view of the planet and is less crowded, but is more expensive to reach.

Geostationary Earth Orbit (GEO) is at 23,000 miles above the equator. A satellite in GEO is orbiting at the same speed as the rotation of the Earth, and so will stay fixed over a particular location. This makes points in GEO vital for communication satellites, and hence very crowded.

There are close to two million operational satellites orbiting the Earth at any one time, ranging from comsats in GEO to the vast squadrons of cheap microsats that different organizations have lobbed into LEO a few hundred miles up. The majority of the latter are football-sized or smaller objects housing anything from imaging sensors to microgravity biolab experiments. The largest unmanned satellites are the hundreds of orbital factories which manufacture precision, high-value microgravity- and vacuum-engineered products such as drugs, foamed alloys, and high-purity crystals. These goods are often picked up by regular service flights and taken to a larger manned station for shipment to Earth or to other space stations.

Most satellites are owned by companies, a sizable number by private individuals, and many by governments. A microsatellite insertion to LEO can cost as little as $5,000, but international agreements are in place to regulate key orbital real estate (such as geostationary orbits), and getting permits to lob something large into space can be a bureaucratic nightmare, unless it's replacing an existing system. The major concern here is overcrowding; there is so much junk in space that professional orbital salvage teams can make a decent living just from scavenging broken systems and sweeping up threatening debris.

Far more sinister are the various satellites operated by military and intelligence agencies. These range from spysats and command-and-control systems to armed space defense platforms and autonomous kill vehicles. The latter are mainly owned by the aerospace forces of China, the European Union, India, Israel, the Islamic Caliphate, the Pacific Rim Alliance, Pakistan, Russia, the Transpacific Socialist Alliance, and the United States. Since the Pacific War, they have been on high alert. If a new space conflict occurs, the action will be exceptionally quick and deadly, as ranges are close enough that evasion is all but impossible. Some nations are believed to have camouflaged extra weapons as civilian satellites. The Revised Outer Space Treaty (p. 86) recognizes the right to enforce a 10-mile approach limit around military satellites.

There are about 400 permanently manned space stations in Earth orbit. The largest is China's Taiko Station spaceport (HEO, transient population 30,000, CR 5), the first stop for many would-be Mars travelers. Rivaling it in size is the Columbia Deep Space Port (transient population 7,000, CR 4), also in HEO. Many older stations are "soda can" habitats constructed between the 2020s and 2040s (before the dominance of big laser rockets) from Chinese, Indian, and Korean heavy-lift vehicle fuel tanks. They are "ghetto" accommodations, often in bad shape: leaking air, low on power, possessing unreliable life support, and infested with fungi or discarded microbots. Investors buy them cheap and rent them to fly-by-night orbital developers, who generally subdivide them into multiple rooms, perform minimal refurbishment, and sublet them to dubious nanotech startup companies. Tracing ownership of these facilities can be difficult.

LUNA ("THE MOON")

Luna, the natural satellite of Earth, is a large rocky body like the four inner planets, although it has only one-sixth Earth's gravity, no atmosphere, and no magnetic field. It was created 4.5 billion years ago when a giant asteroid struck Earth and blasted debris into space; this debris coalesced to form the moon. Luna is tidally locked with Earth, so the near side always faces Earth and the far side always faces away. There is no "dark side of the moon," really, as all areas get sunlight half the time, but as on Mercury, some deep craters near the poles are in permanent shadow. These were discovered to contain small ice deposits.

With no atmosphere to burn up incoming meteors, Luna has been an exposed target in a cosmic shooting gallery for billions of years. The Lunar landscape is dominated by overlapping impact craters. They range in size from a few feet across to the giant South Pole-Aitken Basin (1,400 miles wide and 7.5 miles deep) on the far side, the largest impact crater in the solar system. The Lunar landscape varies considerably between the near and far sides. Flat *maria* – giant asteroid impact craters whose surfaces were later smoothed over by basalt lava flows – cover one-sixth of Luna, and are concentrated on the near side. Most of the far side and much of the near side is made up of the lunar highlands, formed from interlocking large and small craters.

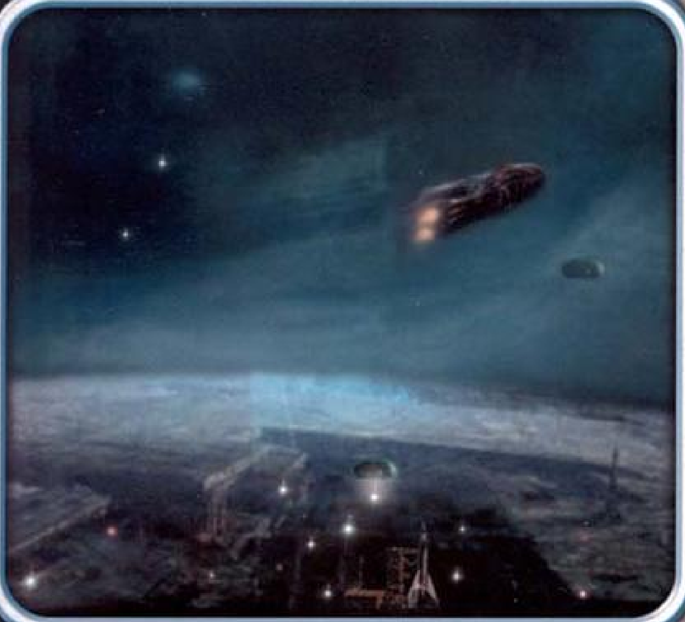
The Lunar surface is covered with regolith, a loose fine-grained material with two major components: dusty rock and mineral particles, and *agglutinates,* mineral and rock welded together by glass produced in meteor impacts. The regolith is exposed directly to the solar wind. This has seeded it with useful volatiles, including traces of both hydrogen and He-3. In addition, about half the mass of Lunar rocks is made of up of oxygen, and there are also economically useful quantities of iron, aluminum, and titanium. However, Luna is incredibly dry, with the only water ice being found intermixed with regolith on the north and south poles.

Luna's population prides itself on being a multinational cosmopolitan society on the cutting edge of Earth's technology. The major industries include He-3 mining (exporting it to Earth), ice and oxygen mining (for domestic consumption and export to Earth-Lunar stations), and heavy manufacturing, especially using processes considered dangerous or polluting on Earth. Much of Luna's infrastructure is owned by the large Euro-Japanese industrial combines System Technologies, Vosper-Babbage, and Tenzan Heavy Industries. The importance of He-3 mining to the Lunar economy is declining due to competition with Saturn. The Lunar combines have diversified into manufacturing and tourism, but even so, there are fears that Luna may become an economic backwater.

Statistics: Luna

Diameter: 2,160 miles.
Mass: 0.0123 Earth masses.
Density: 3.34 g/cm^3.
Gravity: 0.165 G.
Escape Velocity: 1 mps.
To Orbit: 0.7 mps.
Rotational Period: 27.3 days.
Orbital Period: 27.3 days.
Solar Day: 29.3 days.
Atmosphere: Vacuum.
Surface Water: Ice traces in shadowed polar craters.
Temperature: -380 to 250°F (extremes). Mean -240°F (night) to 220°F (day).
Population: 290,000.
Control Rating: 2 to 4.
Spaceports: Large spaceports at Port Tranquility and Luna City, numerous small spaceports.

The majority of lunar "warrens" are underground to provide cosmic-ray and solar-flare shielding. Due to their subterranean lifestyle, Lunar inhabitants are often nicknamed "rabbits." They rarely venture onto the surface themselves, but many have logged surface time in telepresence, especially during school years. Almost all are gene-enhanced, and Luna is very tolerant of aesthetic biomodification. However, econiche parahumans are rare; Luna's environment is simply too unforgiving to make adapting to it worthwhile.



Luna City (population 254,000) is the largest settlement. It is located in Shackleton Crater on the Lunar South Pole, sitting atop major ice deposits. It is a free city, but under the thumb of Euro-Japanese and transnational space corporations. Luna City was badly damaged in an accident in 2085, and part of the infrastructure has been rebuilt as a high-biotech city by Biotech Euphrates.

Farside Observatory (population 300) is located in Tsiolkovsky crater on the far side, and is the oldest settlement on the moon. It is a huge distributed array of radio and optical telescopes. Strict emission control regulations are enforced on Farside to avoid interference with the observatory's activities.

Tranquility Industrial Zone (population 23,000) is scattered across over 100 square miles in the Mare Tranquility region on the near side. An early center for He-3 mining operations, it also boasts Port Tranquility, the largest surface spaceport, and the adjacent "Helium City" manufacturing center. In this thriving economic zone, cybershells outnumber humans by more than 10 to 1. Much of Helium City is above ground and in vacuum. The surrounding waste dumps, mine pits, and junkyards are alive with industrial microbots who often prey upon one another even as they seek to salvage material. The zone is now devoted more to industrial activities than He-3 mining.

Moonshadow (population 5,800) is a major tourist center, health spa and adventure park located in a planned community by shadow ice deposits on the north pole. It is largely owned by SpaTek corporation.

There are hundreds of other outposts on the moon, from oxygen mines to factory crawlers to science labs. Some of them are owned by individual corporations, others by nations, a few by individuals.

THE LAGRANGE POINTS

These are locations in Earth-Lunar space where the gravitational pull and orbital forces of the Earth and Luna cancel each other out. There are five Lagrange points, but L4 (located 60 degrees ahead of Luna's orbit around the Earth) and L5 (located 60 degrees behind its orbit) are especially stable. An object placed there will stay there, orbiting the L4 or L5 point while being carried along by Earth and Luna as they orbit the sun. National space agencies and industrial combines began placing hardware (ranging from telescopes to service stations) in the L4 and L5 points in the early 21st century. In the 2030s the first manned stations were built, supporting Lunar and asteroid prospecting missions. Between 2040 and 2070, Earth-crossing asteroids were moved into the L4 and L5 points for mining. They provided the raw materials to build the many industrial stations and space habitats that exist today. The majority of people live in hollowed-out asteroids or smaller work stations. Only a few giant O'Neill cylinder colonies (p. 75) were constructed, and only after growing space populations, fusion power, and asteroid retrieval made them affordable.

Colonies in the same Lagrange point are usually within 500 miles of each other: the closer they orbit the Lagrange point, the more stable their orbits. Their close proximity means that cheap, lightly built space taxis or scooters can be used to visit neighboring stations. However, some colonies restrict foreign visits to avoid memetic pollution or out of fear of espionage.

Lagrange 4

L4 is the more gentrified of the two Lagrange points. It was the first to be extensively settled, and is now home to a few dozen large colony habitats with a combined population of well over a million people, as well as numerous smaller manned and unmanned stations. Most of the stations were established by governments, major corporations, or well-funded ideological groups.

Islandia, the crown jewel and cultural capital of L4, is a hollow pair of linked cylinders several miles long. Inside is a fully landscaped interior with its own towns, farms, and factories. Islandia is a giant industrial park, resort, and tax-free economic zone built by a coalition of economic interests headed by the orbital and lunar transnationals System Technologies and Tenzan Heavy Industries. The culture is similar to Luna, and is home to a number of transhumanist groups. Islandia has a population of 497,000. It incorporates a large spaceport and is CR 2.

The other L4 stations come in all shapes and sizes, from Bernal spheres and wheel-shaped toruses to cheap "tin cans"; see *Space Habitats,* p. 75. In addition to corporate spaceyards and factories, its several ideological colonies include Margaret (pop. 51,000), a successful experiment in forming a women-only society, Deseret (pop. 32,000), a Mormon colony, and the MacLarren Unity (pop. 4,800) populated by clones of billionaire genius Hiroshi MacLarren.

Lagrange 5

L5 is known as the "junk jungle." A great deal of older hardware in HEO, L4, and Lunar orbit has been towed out to L5 by salvage teams, simply to reduce the risk of debris collisions. It is often resold at scrap prices to whoever wants it, as building material or low-rent habitations. A few captured asteroids are also present, some so heavily mined that they were judged structurally unsound.

This collection of tin cans, "Swiss cheese" asteroids, and other junk is presently home to a sizable population of scavengers, exiles, dissidents, and homesteaders. The L5 explosion occurred in the 2070s, after the development of inexpensive anti-radiation nano made it possible to live in much cheaper space habitats by skimping on shielding. L5 has become a huge trailer park in space. Its inhabitants include many economic refugees and members of fringe ideological groups who split off from orbital stations, L4 colonies, or Luna, to seek their fortunes or to escape persecution. L5 colonies range in population from a few dozen to several thousand people; the smaller colonies are not self-supporting, but survive through contract work for the larger ones. The total population of L5 is uncertain, since some of the ideological colonies have used artificial wombs and cloning to replicate themselves. It could be 40,000-50,000.

L5 natives are nicknamed "Elfs" (*not* elves). Successful Elf colonies include the libertarian preservationists of Cornerstone (population 12,000) and the Christian transhumanists of Seventh Heaven (population 7,000). A few mainstream groups have also located here due to the cheap real estate, and so there are some factory stations, artist's colonies, and research stations. Other Elf colonies are disasters waiting to happen, subsistence operations on the brink of collapse, havens for runaway bioroids, zero-G sweatshops, or petty fiefdoms rife with human rights abuses. There's usually at least one humanitarian crisis every few months, ranging from life support failure to cult suicides to runaway nanoplagues. If a situation is dramatic enough to lead to media coverage, government or nongovernment agencies may intervene to prevent total disaster or clean up afterward. Nevertheless, like many ghettos, L5 possesses a dynamic culture all its own, and some people wouldn't live anywhere else in the system.

MARS

Mars is the fourth planet out from the sun. Half the diameter of Earth and much less massive, Mars' weak gravity sustained only a tenuous atmosphere. The only water in its cold dry climate was locked in polar ice, deep subsurface aquifers, or layers of seasonal permafrost.

Statistics: Mars

Diameter: 4,223 miles.
Mass: 0.107 Earth masses.
Density: 3.9 g/cm^3.
Gravity: 0.38 G.
Escape Velocity: 3.1 mps.
To Orbit: 2.2 mps.
Rotational Period: 24.6 hours.
  Orbital Period: 1.88 years.
  Solar Day: 24.7 hours.
Atmospheric Pressure: Very Thin (0.4 atm.).
Atmospheric Composition: 45% carbon dioxide, 27% oxygen, 21% nitrogen, 2% argon, 5% other.
Surface Water: 20%.
Temperature: 20°F (average).
Population: 2.5 million.
Spaceports: Large spaceports at Phobos and New Shanghai. Multiple small spaceports; numerous space stations in orbit. Space elevator.
Control Rating: CR 1-4.
Moons: Two: Deimos and Phobos.

Terraforming has changed this. The atmosphere is now much thicker (though still very thin compared to Earth's). The air has too high a percentage of carbon dioxide to be breathable by unmodified humans, but a person with an air mask, oxygen tank, and warm clothing can walk safely on Mars with no need for a pressure suit, and modified plants, animals, and even humans can flourish there. Mars remains colder than Earth, with exceptionally harsh winters. Although irrigated areas exist and simple genemod plants such as lichens are spreading, much of the planet is still cold rock-strewn desert, twisted canyons, and barren mountains. Most of the water is in the Marineris and Borealis Seas, but a few large lakes also exist.

The pioneer spirit is alive and well on Mars, with a dynamic population who believe they are building a second home for humanity. Habitations on Mars are a mix of domed, surface, and underground complexes. The largest settlement is China's New Shanghai, but the multinational "free city" of Port Lowell is also booming, serving as a de-facto capital for many smaller national colonies and corporate operations.

Thanks to the space elevator, Mars is experiencing rapid immigration and financial growth. New construction is ongoing, businesses are booming, and sharp entrepreneurs are everywhere, investing, opening up the outback, building homes and farms and factories. Every few months the night sky comes alive (and the cautious head to shelters) as a man-made comet – a redirected Kuiper Belt Object – grazes the atmosphere, adding its load of water and gas to thicken the air. The optimists believe Mars will be fully habitable in 100 years – possibly within their lifetimes. The planet is changing as they watch, and they are changing with it, each generation adapting to the new conditions.

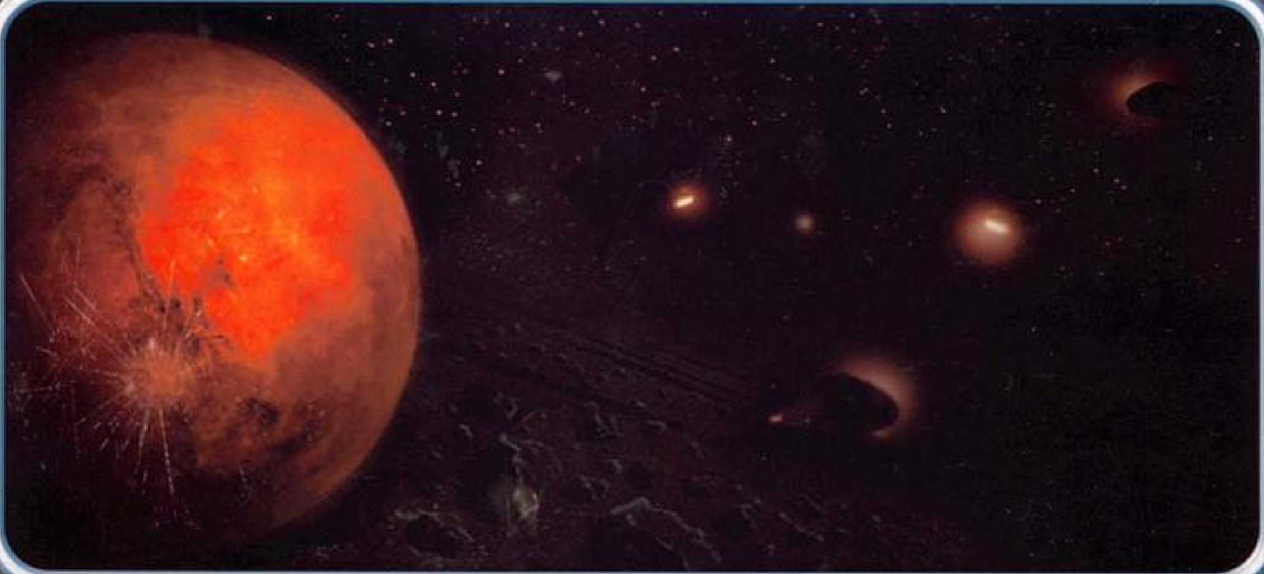
The Martian population is a mix of native-born parahumans (many of them altered to breathe Martian air), indentured bioroids, and immigrants from Earth (some with Mars-adaptive biomods). As space travel has become cheaper, a growing number of tourists and business travelers visit from Earth and Luna.

The largest political entity is China's Mars Province, universally known by its nickname "Rust China." It covers millions of square miles centered on Pavonis Mons (foundation of the Elevator) and the west end of the Marineris Sea. It is an autonomous region (like Hong Kong) of the People's Republic of China with a socialist market economy. Half the population of Mars are Chinese, and immigration is continuing, as Rust China's prosperity draws settlers from Earth. A peculiarity is its high proportion of indentured bioroids. These make up a visible underclass, and are a remnant of the earlier decades of Mars colonization, where China was desperate to increase its population even if it meant mass-producing not-quite-people in artificial wombs.

The second largest colony is the United States' Martian Commonwealth, with a status similar to that of Puerto Rico at the end of the 20th century. It is roughly one-third the area of Rust China, and lies at the east end of the Marineris. A few other countries, notably Peru, have founded smaller national colonies, and there are also outback settlements that do their best to ignore governments. The rest of the population is of mixed ethnic background.

The diversity of interests on Mars often leads to friction. Rust China and the United States' Martian Commonwealth cooperate on terraforming, and there is plenty of commercial and private commerce between both colonies. Nevertheless, they are longtime rivals, with tensions heightened since America's He-3 embargo during the Pacific War. Some Americans are jealous of China's superior position on Mars; some Chinese fear the United States plots to weaken Rust China. Each side has sizable military garrisons, and espionage is common. In addition, there is some tension among other colonies. Peru's Mars colony mostly sat out the Pacific War, but it is a TSA member, and remains at odds with its neighbors, accused of harboring nanosocialist agitators and memetic warfare teams.

In addition to international conflict, a growing number of Martians support complete independence from Earth – the "Free Mars" movement. This meme is vigorously opposed by China, less so by the United States (another source of Sino-American conflict). Mars is also the home of the Martian Triad criminal syndicate, whose



depredations extend well beyond Rust China. Other sources of conflict are radical fringe groups who have resorted to terrorism to get their message across. These range from Preservationist extremists who want to drive humans from the Red Planet to Free Mars radicals and bioroid rights crusaders. The most dangerous group is Negative Growth (p. 106).

Martian Space

Phobos: This moon is 7 miles in diameter, with microgravity and no atmosphere. It resembles an ice-and-rock asteroid. Portions of Phobos were tunneled out by early ice miners. The moon houses the China Aerospace and Xiao Chu corporation's Mars spaceyard. On the surface, many spacedock bays and external-cradle landing pads swarm with hundreds of manned work pods, spacesuited bioroids, and microgravity worker cybershells. The south pole of the moon is a restricted area containing the headquarters of China's Deep Space Fleet. Large spaceport, population 3,000, CR 5-6.

Deimos: This moon is 4 miles in diameter, and similar to Phobos. It is being used to anchor the Martian space elevator. It is now the upper half of Mars' primary orbital spaceport. Like Phobos, it has been extensively tunneled. The inhabited areas and surface house a busy aerospace port. Security is high (CR 6) due to terrorist attempts to sabotage the space elevator.

The Space Elevator: Perhaps the greatest engineering wonder in the solar system, this "beanstalk" is a 10,000-mile-long nanofactured cable connecting Deimos and New Shanghai. It takes two days to travel up or down by cable car.

Mars Orbit: There are thousands of satellites and dozens of space stations in orbit, from global positioning and communication satellites to orbital factories. The United States and China (and to a lesser extent, other governments) also maintain many armed space defense platforms. These are on higher alert than those in Earth, due to ongoing tensions, and the perception of some strategists, not yet tested, that someone could start a "limited war" on Mars *without* an all-out escalation on Earth.

High Arcadia: A luxury theme park located inside a small O'Neill colony built in high orbit. The park has an ancient Greek theme and is inhabited by many genemod uplifted animals, cybershells, and exotic bioroids patterned after Greek mythology, as well as other adventure and cultural activities drawn from classical Greek culture. The park has only recently come online. A controversial element of High Arcadia is that many of its "native" inhabitants have been brought up to believe they really *are* living in mythic Greece.

Orbital Mirrors: A fleet of orbital mirrors reflects light down on Mars to assist with terraforming. The mirrors are hundreds of miles across and made of metallized fabric. They incorporate thrusters for station-keeping.

THE MAIN BELT

"We've been on Ceres five weeks and you're still arguing over what kind of spin-gravity habitat we should put in orbit. Fah! You want weight? Crawl back to Mars, and start begging. The statists might let you land before they put a bullet in your brain. Cole habitat or spin habitat, it doesn't matter. Build either one, and it's theme park Earth. When our kids go outside to work, sure as taxes, they'll screw up. Their reflexes won't be space-adapted, they'll be scared of a puncture or a blowout, and we'll never be able to compete. Face up, everyone: we made a mistake on Mars. Sure, gengineering the Mars bacteria was the right road, but we were heading down it the wrong way! Let's stop trying to create little Earths, and embrace the reality of our environment. We can adapt our unborns, try Katsuki's calcium hack. Tunnel into this rock, make it our home, and come to terms with microgravity. Once we've done it here, we can do it anywhere in the Belt, or beyond. Let the statists squat on Mars. ***Our*** *children will inherit a greater domain, and call all of space their home."*

– Duncanite leader Maya Payne, 2048

The Main Belt is a region between the orbits of Mars and Jupiter, 2 to 4 AU from the sun, that contains the majority of asteroids in the solar system. Asteroids are rocky bodies which orbit the sun, but are too small to be considered planets themselves. They are leftover detritus from the birth of our solar system, prevented by Jupiter's strong gravity from forming into a planet. That was 4.6 billion years ago. Since then, countless collisions have shattered most larger asteroids into smaller ones, and left many of the remainder nothing more than fragments loosely held together by gravity.

Asteroids vary greatly in size. There are 16 large Main Belt asteroids 150 miles or more in diameter, of which the biggest is Ceres, a spherical miniplanet 527 miles across. There are thousands of mid-size asteroids between 10 and 100 miles in diameter, over a million with diameters of half a mile or more, and billions of orbiting rocks from boulder to pebble size. Even so, the total mass of all asteroids, if they could be combined together, is barely enough to form a single moon-sized object about half the diameter of Luna.

Except for a few large bodies like Ceres and Vesta, asteroids tend to have irregular shapes, much like chunks of gravel. Sometimes two asteroids are mashed together as a result of a collision, and end up with very odd shapes.

Asteroids come in several distinct types. The asteroids in the innermost region of the Main Belt (2 to 2.5 AU from the sun) tend to be *stony-irons,* made of a mix of iron and silicate rock, with a smattering of large chunks of *nickel-iron.* The middle regions of the Belt from 2.5 to 3 AU are a blend of stony-irons and soot-colored *carbonaceous* asteroids. These are formed from frozen hydrocarbon sludge mixed with rock and metal chunks, and, from 3 AU onward, water ice. From 3 AU to 4 AU, carbonaceous asteroids are the dominant type. Almost all asteroids contain traces of rare minerals, ranging from platinum to uranium. Since even a fairly small asteroid can mass billions of tons, even trace amounts can represent vast concentrations of ore.

Despite the mineral wealth of the Belt, the asteroids are not alive with hardy prospectors hunting for platinum, gold, uranium or even ice. Asteroids *are* mined, but the process is different: see *Near-Earth Asteroids,* below.

NEAR-EARTH ASTEROIDS

Asteroids whose orbits approach within 1.3 AU of the sun or cross Earth's orbit are known as near-Earth asteroids (NEAs). They are mostly fragments of Main Belt asteroids or the cores of comets whose course has been altered sunward due to collisions with other asteroids or the gravitation influence of Jupiter. NEAs include stony-irons, carbonaceous, and nickel-iron bodies. NEAs are grouped into three categories, named for the first asteroid of each type discovered:

Amors: Asteroids which cross Mars' orbit but do not quite reach the orbit of Earth.

Apollos: Asteroids which cross Earth's orbit with a period greater than once a year.

Atens: Asteroids which cross Earth's orbit with a period less than once a year.

NEAs range from pebbles to about 25 miles across. A few thousand are half a mile or more in diameter. NEAs were the first asteroids to be intensively studied, as they posed a risk to human civilization from collisions. They were also the first to be visited by manned expeditions, and the first to be mined. Many NEAs, including some on dangerous Earth-crossing orbits, have been moved via mass driver into the L4 and L5 points, where they have been used as construction material for space habitats and resources for space factories.

LIFE IN THE MAIN BELT

There are more than 100 populated asteroids in the Main Belt, ranging from large habitats with a thousand or more people to tiny "gas stations" with fewer than a dozen inhabitants. The present population of the asteroid belt is estimated at over 50,000 people, and growing rapidly. Most are farmers, engineers, and researchers, but large stations support diverse occupations.

People aren't looking for precious minerals in the asteroids. Instead, they want freedom. The Duncanites came here fleeing persecution on Mars, and other groups have followed, looking to escape the Babylon of Earth and seek new opportunities to do as they wish. Offworld colonies like Mars, Luna, and Islandia are willing and able to send their square pegs elsewhere, and as the cost of getting into space has fallen, a growing number of Earth-based groups have also funded asteroid colonies to provide places to practice beliefs or policies free of interference.

Corporations have also come to the Belt, seeking the freedom to establish research stations where they don't have to file environmental impact statements or worry about offending the neighbors. It's where people experiment with nanoviruses, self-replicating robots, and antimatter. It's also the site for more controversial experiments in genetic engineering and biogenesis, as it's usually well beyond the reach of would-be protesters and preservationist activists.

A bit of actual asteroid mining *does* go on in the Main Belt, but only to supply the needs of existing communities both here and in the Jovian and Saturn systems.

Asteroid Habitats

Beehive habitats are three-dimensional mazes of tunnels and chambers burrowed into an asteroid. They are microgravity environments. Beehive habitats normally have some surface installations such as landing pads, airlocks, vents, tool sheds, and antennae dishes. For energy, beehive habitats use solar panels in the inner system or nuclear reactors (fission or fusion) in the outer system. Many are constantly expanding, as their inhabitants (or their machines) tunnel deeper in the asteroid every year. If designed to be self-supporting, they will have hydroponics or fauxflesh vats.

Cole habitats are metallic asteroids that were melted and reshaped to create hollow cylindrical metal-hulled stations, then spun to produce artificial gravity on their inner surfaces. Cole habitats may be terraformed with soil and plants, and use mirrors or fusion power to light their interiors.

Gas Stations may be beehive or Cole habitats. Usually built into ice-rich carbonaceous asteroids, they are service stations providing water or hydrogen reaction mass, maintenance, or other amenities. Some stockpile nuclear pellet fuel (for pulse drive engines) as well. A typical gas station also includes maintenance facilities and occasionally shops, motel, and entertainment facilities. Populations range from zero (completely automated) to a few hundred people, depending on sophistication and the services offered. Many gas stations are independent, but a growing number are corporate or corporate franchises, often owned by Vosper-Babbage, Tenzan Heavy Industries, Titan Consortium, and others. A few deep space forces also operate gas stations.

NOTABLE MAIN BELT ASTEROID STATIONS

Here is a representative sampling of the larger Main Belt habitats. All asteroids are microgravity vacuum environments with minimal escape and "to orbit" velocities. The first name is the asteroid's name and designation; the second name is the name settlers gave to their colony.

1 Ceres – Silas Duncan Station

The largest asteroid in the Main Belt, Ceres is a carbonaceous body with a diameter of 527 miles. Silas Duncan Station is the original Duncanite settlement, a beehive habitat with a population of 16,600 living in an anarcho-capitalist society. It is the headquarters of Avatar Klusterkorp and the Green Duncanites (p. 85). Major activities include radical human genetic engineering, bioroid design, bioroid education techniques, pantropy research, and asteroid habitat engineering. Silas Duncan Station has a large spaceport and is CR 1. There are a half-dozen smaller Duncanite habitats on Ceres, established by different families and companies; it's a big asteroid.

2 Pallas – Hesheng Station

The second-largest asteroid, Pallas is a carbonaceous body with a diameter of 309 miles. Hesheng is a beehive habitat with a population of 6,700, many of them microgravity-adapted bioroids. It was settled by China's Xiao Chu corporation and is home to their major nanotechnology research laboratory. Hesheng has a small spaceport and is CR 4.

4 Vesta – Exogenesis Station

Vesta is a rocky asteroid with a diameter of 291 miles. Exogenesis Station is a beehive habitat that houses the Exogenesis corporation's main laboratories and manufacturing complex. A small asteroid was moved into Vesta orbit and converted into a Cole habitat for agricultural and residential use. Vesta has a population of 7,200, mostly researchers and engineers. Many are bioshells and cybershells housing ghosts, shadows, and sapient AIs. The station was the scene of a serious labor dispute last year, and is presently occupied by Executive Decisions Incorporated (p. 94) security forces under the auspices of Nanodynamics. The situation remains tense. It has a small spaceport and is CR 5.

10 Hygiea – Yametei Station

Hygiea is a carbonaceous asteroid with a diameter of 253 miles. Yametei Station is a beehive habitat with a population of 2,400. It is the Main Belt headquarters of Tenzan Heavy Industries and a colony of Japan. Its major activity is manufacturing high-technology goods (such as industrial cybershells, 3D printers, and fusion reactors) for sale to other outer system operations. There is a Duncanite guest worker immigrant population of 100-200 people, mostly Avatar *Tennin* (p. 117). Small spaceport, CR 3.

259 Aletheia – Aletheia Station

Aletheia is a carbonaceous asteroid with a diameter of 111 miles. Its busy beehive habitat (population 5,500) houses the Main Belt headquarters of Vosper-Babbage and Hawking Industries, as well as a Royal Navy Space Service base. Aletheia Station is a colony of the United Kingdom. In orbit around Aletheia are three other small asteroids converted into Cole habitats and containing residential areas and farmland. Major activities include robotics research and development and spacecraft manufacture, servicing, and upgrading, mostly catering to other Main Belt clients. Small spaceport with spaceyard, CR 4.

112434 Shezbeth – Hawking Station

Shezbeth is the solid core of a Kuiper Belt Object, originally located some 40 AU from the sun. At considerable expense, it was moved into the Main Belt, arriving in 2099. It now orbits Aletheia, where the Muldoon black hole (see p. 23) is being studied and used as a gravitic fusion plant to power high-energy physics experiments.

511 Davida – New Covenant Station

Davida is a carbonaceous asteroid with a diameter of 203 miles. New Covenant is a beehive habitat with a population of 4,000. It was founded by Christian hyperevolutionists from the Seventh Heaven L5 colony. It is a cyberdemocratic theocracy in which believers in good standing are chosen at random to serve as ruling ministers. It is a haven for digital creationist activists (see p. 90), and harbors several "liberated" sapient AIs as citizens. There is also a colony of *Astropus* sapient uplifts (p. 118) – space-adapted octopuses – who broke away from Exogenesis with a few stolen SAI programs and are seeking sanctuary (and looking to convert). Major economic activities include development of computer hardware, new brain implants, intelligence augmentation, and uploading technology. Small spaceport, CR 1.

704 Interamnia – Liberty Bell Station

Interamnia is a carbonaceous asteroid with a diameter of 197 miles. This asteroid houses a gas station and Plymouth Rock homestead composed of six extended families (population 50). Interamnia has a smaller terraformed Cole habitat orbiting it housing farms (raising animals for food!), plus various facilities for entertaining visiting spacer crews. CR 2, and has a space dock.

Other Asteroid Stations

As there are millions of asteroids and a hundred or so stations, the GM should feel free to create additional asteroid bases of varying purpose and population. Many are run by small groups, often with counterculture beliefs: cults, racial supremacists, survivalists, and others. Most are 2 to 4 AU from Earth.

OUTER SYSTEM

The outer system extends from beyond the Main Belt to the heliopause. Half a billion miles or more from the sun, well beyond the freezing point of water, the majority of celestial bodies are giant balls of gas or frozen ice and rock.

JUPITER

Jupiter is the largest planet in the solar system, with a diameter 11 times that of Earth and over 300 times its mass. Its upper atmosphere is shrouded in alternating bands of light and dark red, brown, and white ammonia clouds. Jupiter's weather is violent, with hurricane-force winds and cyclones vaster than planets that rage for centuries at a time. Beneath the clouds lies the true Jupiter: a vast superdense atmosphere of hydrogen and helium, thousands of miles deep, that gradually turns liquid as the pressure increases. Under this strange ocean is a hot, electrically conductive layer of liquid metallic hydrogen, surrounding a solid core about the size of Earth.

Statistics: Jupiter

Diameter: 88,850 miles.
Mass: 317.8 Earths.
Density: 1.33 g/cm^3.
Gravity: 2.36 G.
Escape Velocity: 37 mps.
To Orbit: 26 mps.
Rotational Period: 9.9 hours.
Orbital Period: 11.86 years.
Atmospheric Composition: 90% hydrogen, 10% helium, traces of other elements, mostly ammonia and methane.
Temperature: -240°F (cloud tops).
Moons: 28+ including Metis, Adrastea, Amalthea, Thebe, Io, Europa, Ganymede, Callisto, Leda, Himalia, Lysithea, Elara, Anake, Carme, Pasiphae, Sinope, and many smaller hill- and boulder-sized bodies.

Jupiter's gravity is also impressive, exerting a major influence on other smaller bodies like asteroids and comets. The high gravity and equally high escape velocity is one reason the Titan Consortium chose to perform gas mining operations around more distant Saturn. The other reason is radiation.

Jupiter has a powerful magnetic field, and when charged particles from the solar wind become trapped in its magnetosphere, they are accelerated to very high velocities, creating deadly belts of radiation similar to but far more powerful than Earth's Van Allen belts; see *Radiation Hazards,* p. 59. The orbits of several of Jupiter's moons pass through this zone, endangering would-be visitors.

Like Saturn, Jupiter is orbited by rings. Jupiter's are darker and less extensive, composed of small rocky grains and gravel chunks rather than ice.

Manned exploration of Jupiter is presently impossible, but telepresence and cybershell probes have ventured beneath its clouds, and a few have penetrated into the liquid hydrogen seas. There are currently several dozen cybershells engaged in planetary exploration, mostly for scientific foundations.

Jupiter's atmosphere has some of the ingredients for life, but so far no life has been found. This has not stopped some among the Green Duncanites from investigating the possibility of *creating* Jovian life.

Jupiter has not been colonized, but human settlements have been placed on some of its many moons. Transjovian space is a new frontier. The prizes for development are water ice (refined into oxygen and hydrogen, for life support and reaction mass) and gravity (for slingshot effects), and Europa itself.

EUROPA

Europa is the sixth moon of Jupiter, the third-largest, and the first to be visited by humans. It is slightly smaller than Luna, and the surface is exposed to Jupiter's radiation belt (see *Radiation Hazards,* p. 59). Europa is lightly cratered, with only three large impact sites. Its bright surface consists of a 6- to 10-mile-thick crust of water ice, scored by ridges and lines. It resembles sea ice on Earth – which is not surprising. The ice covers a vast salt-water ocean, warmed by tidal heating. The ocean is 60 miles deep, and holds more water than does Earth's! Europa's orbit around Jupiter creates stresses that flex the moon's core, causing hydrothermal vents to open in the ocean floor. These "hot smokers" create conditions where extraterrestrial life has evolved: the vents are fiery geysers surrounded by bacteria-encrusted rocks.

Life on Europa consists of two basic bacterial ecologies: cold-loving psychrophiles in the oceans, and various thermophiles near the volcanic vents. The latter, *Parapyrolobus europae,* have some similarities to the terrestrial vent-form bacteria *Pyrolobus fumarii.* There is fleeting evidence of larger organisms.

There are three major bases on Europa. All are tunneled deep into the ice. Each installation has one or two well shafts that lead down a few miles to the ocean itself. The surface facilities are many hundreds of miles apart, and as a result, above-ground contact between them is minimal. Bases were established in craters, where the ice has already been partially cracked.

CRABE: The oldest base on Europa, populated by 70 astrobiologists and support staff. It is located in the 16-mile wide Pwyll impact crater. Europa station controls several cybershell research submarines and numerous swarms of swimmer microbots. CRABE is financed by the E.U.; the name stands for *Centre de Recherche AstroBiologique d'Europa.*

Statistics: Europa

Distance from Jupiter: 0.0045 AU.
Diameter: 1,950 miles. *Mass:* 0.008 Earths.
Density: 3 g/cm³.
Gravity: 0.13 G.
Escape Velocity: 1.2 mps.
To Orbit: 0.87 mps.
Rotational Period: 3.55 days.
Orbital Period: 3.55 days.
Surface Water: Ice on surface. Ocean covers 100% of moon under ice.
Temperature: -260°F.
Atmosphere: Traces of oxygen; effectively vacuum.
Population: 500 (uncertain).
Spaceports: None; spacedocks at each base.
Control Rating: CR 0.

Genesis Station: This is a Green Duncanite colony operated by Avatar Klusterkorp. It is located in the Thera Macula region, an area of jumbled "chaos terrain" formed when a plume of warm water melted through the ice. Genesis Station has been seeding Europa with hybrid terrestrial life forms modified to survive in the vent environment. Recent attacks on its facilities have led to Avatar importing its own defenses. The "War Under the Ice" may escalate.

Manann'an Station: This facility was a former ESA base, later abandoned due to budget cuts. It was refurbished and taken over by a private astrobiology research foundation. The foundation is actually a front for the Europa Defense Force, a radical preservationist group. The EDF has imported armed mini-subs and bioroid soldiers, and has begun a program aimed at eradicating the Genesis forms. The station occupies part of the 19-mile wide Manann'an crater near Europa's trailing hemisphere.

OTHER JOVIAN MOONS

Jupiter has 16 moons 10 miles or more in diameter, and several smaller moons. The largest moons are the four discovered by Galileo: Io, Ganymede, Europa, and Callisto. The innermost moons share their orbits with multiple rings formed from small boulders (a few yards across), pebbles, and dust particles.

Io

This moon is about the same size as Luna, but is unique in the solar system. It looks a bit like a hot pizza. Its proximity to Jupiter, Ganymede, and Europa causes massive tidal flexing, torturing Io's geology. The mountainous surface is alive with active volcanoes, which send plumes 200 miles into the sky, and violent moon-shaking quakes. Flows of sodium-rich lava stretch for hundreds of miles. The temperature range is dramatic, from 3,000°F rivers and lakes of molten lava to -225°F elsewhere. Io is heavily irradiated by Jupiter's radiation belt: see *Radiation Hazards,* p. 59.

Io Base: Exogenesis (p. 94) has a cybershell presence on Io, with a few automated bases and an estimated population of about 300 sapient infomorphs. No human has ever visited its surface. There have been unconfirmed reports of conflict between bases, following the recent Exogenesis labor dispute.

Io is 0.0028 AU from Jupiter. It has a diameter of 2,263 miles, a gravity of 0.183 G, and an escape velocity of 1.6 mps. It has a small spaceport and CR 0.

Ganymede

Ganymede is the largest moon in the solar system, bigger than Mercury or Pluto. It is mostly dirty ice over a rocky core. The temperature is a chilly -250°F. Like Europa, Ganymede has a deep ocean of salt water underneath its ice. However, Ganymede's ocean is far less accessible: 60 miles beneath the moon's frozen surface. There is no evidence (so far) of hydrothermal vents or life forms.

Ganymede is 0.0071 AU from Jupiter. It has a diameter of 3,270 miles, a gravity of 0.145 G, and an escape velocity is 1.7 mps (1.2 mps to orbit). It is unpopulated, but occasionally visited by scientific missions.

Callisto

The second-largest of Jupiter's moons, icy Callisto is the most heavily cratered body in the solar system, although it has no large mountains. Callisto is far enough from Jupiter that radiation is minimal (0.01 rads/day) and is big enough that its crust contains minerals as well as ice. The surface temperature is a chilly -233°F. Like Ganymede, Callisto has a nearly inaccessible subsurface ocean buried deep beneath its ice.

Asgard Station: The large ringed Asgard crater is home to a manufacturing base and robofac complex established by Nanodynamics (p. 95). Asgard is intended to supply operations in the Main Belt and Titan. Asgard has a population of 400 and is growing. A mass driver is being built to hurl ice out to other colonies in the inner and outer system. It has a small spaceport and CR 2.

Valhalla Station: A colony founded by Red Duncanites from Liang Mountain, in Valhalla crater. Originally a mining station, it is presently used as a data haven and production center for gray-market mind emulations. The facility was originally located in Bangkok, but following the fall of the Thai government, was moved first to Lagrange 5, and later (in partnership with the Duncanites) to Callisto. It has a small spaceport. Population 100. CR 0.

Callisto is 0.0125 AU from Jupiter. It has a diameter of 2,986 miles and a gravity of 0.127 G. Its escape velocity is 1.5 mps.

Jupiter's Outer Moons

Jupiter has a few dozen smaller moons beyond the orbit of Callisto. These range in size from a couple of miles to 112 miles in diameter. They are all cratered ice-and-rock bodies, probably captured asteroids, many with highly eccentric orbits. A few have been visited, but no known settlements exist.

THE TROJANS

The Trojans are loose collections of asteroids located at Jupiter's Trojan points, a pair of locations where the gravity of Jupiter and the sun cancel out, creating areas of gravitational stability similar to the L4 and L5 points in the Earth-Moon system. The asteroids are named after heroes from the Trojan War. The "leading" or "Greek" Trojans are located 60° ahead of Jupiter in its orbit and consist of about 1,300 sizable asteroids (over 10 miles across) and countless smaller ones. Similarly, the "trailing" or "Trojan" Trojans are 60° behind Jupiter, with over 1,000 sizable asteroids and many smaller ones.

The asteroids at each Trojan Point are in very loose clusters, with a density not much greater than the Main Belt. Many are not even directly in the plane of Jupiter's orbit, but have declinations up to 40° and right ascensions up to 70° from the actual true Trojan Point.

Trojan asteroids have somewhat different compositions than the asteroids in the Main Belt. The majority of Trojan asteroids are "D-type" dark-colored bodies. These are similar to carbonaceous asteroids (see *The Main Belt,* p. 39), but with a high proportion of carbon polymers and organic-rich silicates.

Notable Trojan Asteroids

The majority of settlers in the Trojans have been members of the "Red Duncanite" (p. 85) splinter group. Most of the population are *Tennin* Avatar parahumans and various bioroids and infomorphs.

911 Agamemnon – Freehaven. Agamemnon (leading Trojans) has a diameter of 104 miles. Freehaven is a beehive habitat with a population of 2,200. It is a Red Duncanite enclave. It has a small spaceport and CR 0.

1437 Diomedes – Liang Mountain. Diomedes (leading Trojans) has a diameter of 102 miles. Liang Mountain has a population of 1,400 and is one of the headquarters of the so-called "Trojan Mafia" (p. 85). It is a left anarchist society. Liang Mountain has a small spaceport and CR 1.

617 Patroclus – Varahamihira Station. Patroclus (trailing Trojans) has a diameter of 88 miles. It houses a research facility run by the Indian National Space Institute (a government body) in conjunction with Bangalore Aerospace Limited and (allegedly) the Indian military. Population 700. Small spaceport, CR 5.

SATURN

Saturn, the ringed planet, is the sixth out from the sun and the second-largest in the solar system. Saturn is a gas giant like Jupiter, but less dense. Its atmosphere is hazy yellow, with softer bands of deeper shades of yellow and ochre. It rotates quickly for its size, and the atmosphere is cold (-238°F) but very turbulent. Equatorial winds can reach 1,100 mph, with wind speed slackening toward the poles.

Saturn's atmosphere is the setting of Titan Consortium's helium-3 gas mining operations. Nuclear-powered drone scoop spacecraft from Cassini Station regularly dive into the atmosphere to retrieve loads of gas. It is processed at Cassini Station, and tankers full of He-3 are launched toward Earth or Mars. Saturn has a radiation belt like Jupiter's, but only about 5% its strength, making it much less of a hazard for space navigation and colonization.

Statistics: Saturn

Diameter: 74,900 miles.
Mass: 95.2 Earths.
Density: 0.69 g/cm^3.
Gravity: 0.91 G.
Escape Velocity: 22 mps.
To Orbit: 15.4 mps.
Rotational Period: 10.7 hours.
Orbital Period: 29.4 years.
Atmospheric Composition: 96% hydrogen, 3% helium, 0.05% methane.
Temperature: -290°F (cloud tops).
Population: varies.
Spaceports: Large: Cassini Station, in orbit. Usually unmanned, but inhabited by dozens of AI and ghost-controlled cybershells.
Control Rating: CR 4 at Cassini Station.
Moons: 30+; see below.

Saturn's Rings

Saturn is orbited by a complex system of multiple rings of icy particles from moons that formed too close to Saturn and which were torn apart by its gravity. Pebble-sized ice pellets occur every few yards, while icebergs the size of houses can be encountered every mile or so. However, all the material in a given ring orbits Saturn at the same velocity and in the same direction, so a spacecraft pilot (or suited astronaut) can match velocity with, and maneuver safely through, the rings. Gravitational interactions with Saturn's moons split the ring system into several different parts. The most visible are the bright, dense "A" and "B" rings and the fainter "C" ring, but the orbits of Saturn's moons result in four distinct ring systems and many subdivisions and gaps. The most notable gap is the Cassini Division, which separates the A and B rings.

The rings are occasionally mined by manned and robot spacecraft to provide water for Titan and other colonies. They are also an excellent place for spacecraft to hide, and there have been reports of rogue AKVs from the Pacific War lurking in the ring system.

SATURN'S MOONS

Saturn has over 30 moons. The major moons (those with diameters over 70 miles) are Mimas, Enceladus, Tethys, Dione, Rhea, Titan, Hyperion, Iapetus, and Phoebe. As with Jupiter's moons, they are primarily water ice with rocky cores, although Enceladus possesses a subsurface ocean like Ganymede.

Human settlements have sprung up on Mimas, Titan, Hyperion, and Rhea.

Mimas

The innermost large satellite of Saturn, its topography is dominated by Herschel, a huge, deep crater 80 miles wide. As this is one-third the size of Mimas, the moon appears to have a giant "eye" looking out. Herschel's walls are 3 miles high, and parts of its floor are 6 miles deep. There is a central mountain peak (caused by a pressure rebound from the impact) in the midst of the crater that rises 4 miles off the crater floor. Christian hyperevolutionists from New Covenant Station recently established the Eye of God monastery (population 70) on the peak, which also functions as a resort and biomodification clinic for the faithful.

Mimas is 0.0012 AU from Saturn. It has a diameter of 247 miles, a gravity of 0.0003 G, escape velocity 0.1 mps (to orbit, 0.07 mps) and no atmosphere. The temperature averages -330°F. It has a small spaceport and CR 3.

Hyperion

Hyperion's orbit is adjacent to that of Titan. This small moon has a very irregular shape and rotation, making for chaotic terrain and difficult landings! It was originally the hideout of the notorious "pirates of Hyperion" who raided He-3 shipments during the Pacific War. The pirate base was captured by the 82nd Spaceborne, and Hyperion is now used as a hostile-environment training area and free-fire range. It is posted as a restricted area; a pair of Predator AKVs enforce a quarantine. Spacedock facilities exist.

Hyperion is 0.0097 AU from Saturn. It is an irregular body 255 miles by 162 miles by 136 miles, with variable microgravity (due to its unusual rotation), escape velocity 0.06 mps (0.042 to orbit) and no atmosphere.

Rhea

The largest of Saturn's icy moons. It is two-thirds water ice, one-third rock. The leading hemisphere is heavily cratered, compared to the smoother trailing hemisphere. Rhea is the home of the USAF's Cassini Air Force Base. It has a population of 1,200, half of them military or dependents.

Rhea is 0.0035 AU from Saturn. It has a diameter of 949 miles, a gravity of 0.027 G, escape velocity 0.4 mps (0.28 mps to orbit), and no atmosphere. The temperature is -280°F in the sun, -360°F in the shade. It has a large spaceport with a growing Columbia Aerospace spaceyard facility and nuclear-pellet production facility. It is CR 3.

TITAN

Titan is the second-largest moon in the solar system and the 15th of Saturn's satellites. Its surface is shrouded by opaque orange clouds. It is the only moon to possess an atmosphere with a density comparable to Earth's. Rich in hydrocarbon resources, Titan is the *de facto* capital of the Deep Beyond and the pride of America's space colonization program.

Titan's composition is about half water ice and half rocky material. It has no magnetic field, but its atmosphere has 1.5 times the surface pressure of Earth, and acts as an effective shield against radiation.

Titan is freezing cold, at -290°F. However, its dense atmosphere means humans do not need pressure suits – a heated, specially insulated suit, air tank, and an oxygen mask are sufficient. The atmosphere is primarily molecular nitrogen with 6% argon, a few percent methane, and traces of water vapor. The breakdown of methane by sunlight in the upper atmosphere forms thick organic photochemical smog (similar to city smog, but much denser). This haze hides the surface from visual observation.

Titan has many Earthlike features, including seas, rainfall, and volcanic activity. However, the seas and lakes are composed of liquid methane, the raindrops are liquid methane, and the "hot lava" that volcanoes spew forth is composed of liquid water and ammonia. Titan's atmosphere has been compared to Earth's primeval soup, and its surface and oceans are a breeding ground for complex organic molecules. The sky is a soft orange, as light shines through the hazy smog. The surface is a pastel landscape of orange, pink, and yellow. The land is cut by rivers and lakes of methane in which ethane icebergs drift. There is one larger body of liquid, the Minoan Sea. The U.S. Titan Territory, the largest human colony, is located on a lowland river nexus known as the Nubian Valley. The small Chinese colony is found near the Mayan Plateau, a region of cryo-volcanic highlands.

The U.S. Titan Territory provides support for numerous manufacturing and fuel processing centers on Saturn's other moons. Titan's low gravity and thick atmosphere make it easy for transatmospheric vehicles with methane-burning fission rockets and fission air-rams to boost into orbit, facilitating export of bulk chemicals to Rhea, the Belt, or even Mars.

Statistics: Titan

Distance from Saturn: 0.081 AU.
Diameter: 3,200 miles.
Mass: 0.0226 Earths.
Density: 1.88 g/cm^3.
Gravity: 0.14 G.
Escape Velocity: 1.6 mps.
To Orbit: 1.12 mps.
Rotational Period: 15.9 days.
Orbital Period: 15.9 days.
Atmospheric Pressure: 1.5 Earth (density is 4.5 Earth).
Atmosphere Composition: 90% nitrogen, 4% methane, 6% argon.
Surface Water: 40% of surface is liquid hydrocarbons.
Temperature: -290°F.
Population: 60,000.
Spaceports: Large spaceport (Titan Station, pop. 400) in orbit. Large spaceport (Port Minos and Titan AFB); small spaceport (Jiangli Station) on surface; Titan Orbital Spaceport (small spaceport) in orbit.
Control Rating: CR 3.

The capital of Titan Territory is Huygens City, a cluster of domed habitats with a population of 47,000, surrounded by miles of chemical refineries and factories. Adjacent to it is Port Minos (a large spaceport) and Titan AFB. Life at Huygens has a company-town atmosphere; a sizable chunk of the population are on two- or four-year contracts as teleworkers, AI trainers, or other support staff. In addition, soldiers and workers from Rhea usually show up on liberty every two or three weeks. Minos is famous for its love-doll rental dealerships, capsule hotels, Duncanite curio shops, and slinky vendors. Others prefer to explore Titan in person: backpacking, methane ice skating, and human-powered flight are common. There are several outback research stations, semi-automated robofacs, and experimental farms, some attempting to engineer Titan-adapted life forms. The *real* colonists of Titan are found here: cybershells and other exotics carefully engineered to make Titan their home. There is some tension between the permanent colonists and the temp workers and soldiers.

Xiao Chu has established a factory complex on Titan, Jiangli Station, supposedly to begin nitrogen mining to support its growing Main Belt operations. This is viewed with alarm by the U.S. military, as the base is rapidly expanding, adding defensive systems and bioroids, some optimized for the environment. Jiangli Station has a population of 1,700 and its own small spaceport.

Titan's combination of low gravity and a dense atmosphere makes it a paradise for aircraft. Transatmospheric vehicles fuelled by methane ramjets easily reach orbit. Transport on the surface uses hovercraft, helicopters, and aircraft.

URANUS

Uranus is the seventh planet from the sun. A gas giant like Jupiter, its blue-green color is the result of red light being absorbed by methane in its atmosphere. Unlike other planets, it rotates sideways relative to the plane of the solar system, possibly due to some ancient collision. Uranus is colder and smaller than Saturn and Jupiter, and much more of its mass is a solid core. Its atmosphere is calmer than those of its larger brethren, although still turbulent by terrestrial standards, with winds of 60 to 370 mph.

Uranus has faint rings of dust particles and small rocky boulders, and 21 moons, all fairly unremarkable airless balls of rock and ice. The largest are Titania and Oberon, both just over 900 miles in diameter.

Statistics: Uranus

Diameter: 31,800 miles.
Mass: 14.5 Earths.
Density: 1.3 g/cm^3.
Gravity: 0.89 G (upper clouds).
Escape Velocity: 13.2 mps.
To Orbit: 9.3 mps.
Rotational Period: 17.2 hours.
Year: 83.7 years.
Atmospheric Composition: 83% hydrogen, 15% helium, 2% methane.
Temperature: -355°F (cloud tops).
Moons: 21; see below.

Miranda

The 11th moon out from Uranus, Miranda is mostly ice and rock, with an odd "jigsaw" geology of crazy canyons (some up to 12 miles deep) and jumbled features. Xiao Chu has established a scientific base to study its geology. The population of 120 humans appears excessive for such a station, which would normally be staffed mainly (or exclusively) by cybershells.

There are rumors that Miranda Station is a first step in an effort by China to begin He-3 mining of Uranus. While farther away than Saturn, the lower gravity and less-fierce weather might make operations (in the long term) cheaper than Saturn. It would also prevent the United States from interfering with any Chinese He-3 mining operations.

Miranda is 0.00086 AU from Uranus. It is about 290 miles in diameter with a gravity of 0.0079 G and escape velocity 0.12 mps (0.08 mps to orbit). Surface temperature is -335°F.

NEPTUNE

Blue Neptune is the eighth planet from the sun – or sometimes the ninth planet, as Pluto's orbit is quite eccentric. It is the most distant gas giant. Neptune is similar in size and composition to Uranus, but a little smaller, a bit hotter, and with a more active atmosphere. The winds in Neptune's atmosphere are the fastest in the solar system. They can reach speeds of 1,200 mph, creating an ever-changing cloud system and violent world-sized cyclones similar to those of Jupiter, but more short-lived.

Statistics: Neptune

Diameter: 30,800 miles.
Mass: 17.1 Earths.
Density: 1.6 g/cm^3.
Gravity: 1.12 G (upper clouds).
Escape Velocity: 14.5 mps.
To Orbit: 10.2 mps.
Rotational Period: 16.1 hours.
Year: 164.8 years.
Atmospheric Composition: 74% hydrogen, 25% helium, 1% methane.
Temperature: -380°F (cloud tops).
Moons: Eight; see below.

Neptune has eight sizable moons and the usual collection of orbiting rocks and captured asteroids. The majority of Neptune's moons are airless, cratered, rocky ice balls, with one exception:

Triton

Neptune's largest moon is 1,680 miles in diameter. Its low density (2 g/cm^3) suggests it is a captured Kuiper Belt body like Pluto. Triton has a trace atmosphere of nitrogen and methane – effectively a vacuum. Its surface has few craters but is scarred by enormous cracks and fissures from cryo-volcanism and covered with nitrogen ice (with pink methane ice on the south polar cap).

The core is heated by tidal interactions with Neptune, resulting in nitrogen ice and dust geysers that erupt on the surface, spewing plumes miles into space. It is *very* cold, with a surface temperature of -390°F.

Escape velocity is 0.9 mps (0.63 mps to orbit). Gravity is 0.08 G.

The U.S. Astrographical Service sent cybershell explorers to Triton in the 2070s, but humans only experienced Triton through badly light-lagged telepresence. The last cybershells ceased functioning in 2090. However, statements and disclosures made by System Technologies AG following their sale of Exogenesis suggest the latter corporation may have established a secret research station here, with an infomorph or bioroid population of unknown size.

THE KUIPER BELT

There are millions of cold, icy bodies beyond Neptune, circling the sun in long eccentric orbits. Most occupy a wide band around the plane of the ecliptic, the Kuiper Belt, between 42 and 50 AU from the sun, although scattered objects can be found as orbiting as far out as 150 AU. The bodies populating it are leftovers from the birth of the solar system, and consist of a nucleus of rock less than a mile or two across surrounded by a ball of frozen dust and gas. Over 70,000 of these Kuiper Belt Objects (KBOs) are more than 50 miles across. Several are hundreds of miles across, comparable in size to Pluto.

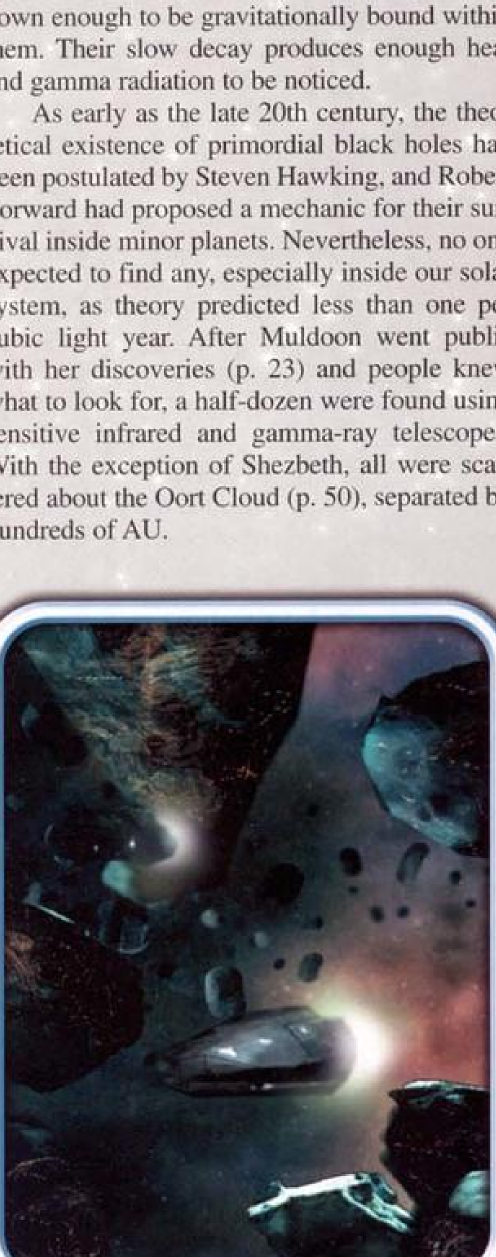
Many KBOs are in stable orbits, but sometimes a KBO's trajectory is affected by the gravitational interaction of Neptune or Uranus, slinging it out of the solar system into the Oort cloud, or on a new orbit that will carry it through the inner solar system. As a KBO approaches the sun, it becomes a short-period comet: its outer layers begin to evaporate, creating an aura of dust and gas, or coma. The solar wind blows this away from the sun, producing the comet's long glowing tail, which always points away from the sun. Over multiple passes, some comets lose all their ice and frozen gases (such as methane), leaving only a rock core.

The Kuiper Belt has a transient population of spacers engaged in "comet herding" operations to support Mars terraforming. Fusion torch engines are installed on KBOs using their own ice as fuel to accelerate them into the inner system, on trajectories that will end up grazing the Martian atmosphere, evaporating and depositing their ice as water vapor. The Kuiper Belt's population is estimated at about 2,000, mostly parahumans, bioroids, and infomorphs. Many are Gypsy Angels (p. 86); others belong to various space corporations. A few KBOs are rumored to house permanent Duncanite populations; there have been some reports of unidentified spacecraft, and rumors that cybershell vessels are *replicating* there, for reasons unknown.

PRIMORDIAL BLACK HOLES

These atom-sized mini black holes formed during the early stages of the Big Bang. Despite their tiny size, they mass a few billion tons, about the same as a mid-sized asteroid. Most primordial black holes evaporated in a storm of energy a few billion years ago, but a few were large enough to survive. Some appear to have had close encounters with other celestial bodies (mostly the many billions of chunks of rock and ice in the Kuiper Belt or Oort Cloud). Braked by tidal forces as they interpenetrated, they slowed down enough to be gravitationally bound within them. Their slow decay produces enough heat and gamma radiation to be noticed.

As early as the late 20th century, the theoretical existence of primordial black holes had been postulated by Steven Hawking, and Robert Forward had proposed a mechanic for their survival inside minor planets. Nevertheless, no one expected to find any, especially inside our solar system, as theory predicted less than one per cubic light year. After Muldoon went public with her discoveries (p. 23) and people knew what to look for, a half-dozen were found using sensitive infrared and gamma-ray telescopes. With the exception of Shezbeth, all were scattered about the Oort Cloud (p. 50), separated by hundreds of AU.



Statistics: Pluto

Diameter: 1,485 miles.
Mass: 0.0021 Earths.
Density: 2 g/cm^3.
Gravity: 0.067 G.
Escape Velocity: 0.68 mps.
To Orbit: 0.48 mps.
Rotational Period: 6.4 days.
Year: 248 years.
Atmosphere: Vacuum.
Surface Water: None. Water ice.
Temperature: -400°F.
Moons: Charon.

PLUTO

Pluto has a highly eccentric orbit: it and Neptune exchange honors as the outermost planet, a title Pluto will hold until 2226, when it moves inside Neptune's orbit. Many don't consider Pluto a planet at all, but simply the most famous Kuiper Belt Object. Its surface is composed of frozen nitrogen, methane, and carbon monoxide ice over water ice, with a rocky core.

Pluto is not believed to be inhabited, but no one has checked since the last cybershell probe ran out of power in 2082.

Pluto has its own moon: Charon, which is 790 miles in diameter.

THE OORT CLOUD

The Oort cloud is an outer cloud of trillions of icy bodies and comets in long eccentric orbits circling the sun at distances of around 100,000 AU. The outer Oort cloud of the solar system merges with that of Alpha Centauri. Long term plans have been made for robotic missions that will eventually cross to Alpha Centauri in this fashion, using Oort cloud objects as a source of reaction mass – stepping stones to the stars. A couple of expeditions have been sent into the Oort clouds, or are in the process of voyaging there, some of them chasing after a half dozen or so primordial black holes believed to exist here.

SPACE TRAVEL

"Reach low orbit and you're halfway to anywhere in the solar system."
– Robert A. Heinlein

INTERPLANETARY DISTANCES

Interplanetary distances are measured in astronomical units, or AU. One AU is the average distance from the Earth to the sun: 93,000,000 miles or about 500 light-seconds. (A light-second is the distance light can travel in a second: 186,000 miles.) The distance separating two planets in a star system may be as short as the difference between their distances from their star or as long as the sum of those distances, depending on their orbital positions. The table below shows the differences between major bodies:

THE BLACK HOLE CONTROVERSY

A number of questions regarding the discovery and origin of the primordial black holes remain unanswered.

First, was Dr. Muldoon (p. 23) really the first to discover them, and did she deserve sole credit? There are also indications that other observatories noticed gamma-ray signatures linked to the Shezbeth hole in the 2020s or earlier, but that their significance went unrecognized. Muldoon claims she did not access any of this data, but all witnesses to her sky-sweep were lost with the destruction of the Chatarang Space University during the Pacific War.

Second, the number of local holes is higher than that predicted by cosmological theory. This fact that has led to a spate of new theories, and much scratching of heads.

Third, some physicists reject the proposed mechanics of black hole capture, arguing that the mini black hole would have passed right through the KBO or Oort cloud object unless both its course *and* relative velocity were very similar, something that would be a remarkable coincidence.

These issues have led conspiracy theorists to suggest a mini black hole was not all the Muldoon expedition found on 112434 Shezbeth, and that other things were removed before the object was moved into orbit around Aletheia. *Alan B. Shepard's* crew were infomorphs provided by the enigmatic Christian hyperevolutionists; such entities can have their minds edited. Hawking Industries and its associates dismiss all such claims as baseless.

> **All things are artificial, for nature is the art of God.**
> **– Sir Thomas Browne**

Interplanetary Distances (AU) on Jan. 1, 2100

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto	Aletheia	Ceres	Davida	Hygiea	Interamnia	Pallas	Vesta	Achilles	Patroclus	Agamemnon	Diomedes
Planets																				
Mercury	–	0.72	1.38	1.76	5.66	9.81	19.84	30.55	48.9	3.24	2.95	3.38	2.87	3.69	2.98	2.87	5.61	5.99	5.44	4.84
Venus	0.72	–	1.12	1.14	6.17	10.39	19.25	30.8	48.25	2.61	2.24	3.77	3.5	3.7	2.95	2.28	6.22	5.7	6.13	4.74
Earth	1.38	1.12	–	0.88	5.53	9.86	19.8	29.8	48.59	3.29	2.17	3.06	3.28	2.65	4.02	1.7	6.92	4.71	6.29	5.85
Mars	1.76	1.14	0.88	–	6.41	10.7	19	30.45	47.75	2.55	1.33	3.91	4.12	3.25	3.8	1.15	7.34	4.8	7	5.53
Jupiter	5.66	6.17	5.53	6.41	–	4.37	25.4	25.4	53.85	8.72	7.62	2.67	3.05	4.18	8.23	6.82	7.46	6.7	4.71	10.1
Saturn	9.81	10.39	9.86	10.7	4.37	–	29.6	22.9	58.13	13	12	6.94	6.99	8.46	12	11.18	9.74	10.5	6.81	13.7
Uranus	19.84	19.25	19.8	19	25.4	29.6	–	48	31.05	16.7	17.85	22.8	22.7	21.8	18	18.8	22.5	21.3	24.41	16.9
Neptune	30.55	30.8	29.8	30.45	25.4	22.9	48	–	72.2	32.9	31.16	27.3	28.4	27.3	33.3	30.1	32.4	27.1	29.1	35.3
Pluto	48.9	48.25	48.59	47.75	53.85	58.13	31.05	72.2	–	45.7	46.5	51.6	51.6	49.8	47.8	47.23	51.9	49.25	53	46.9

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto	Aletheia	Ceres	Davida	Hygiea	Interamnia	Pallas	Vesta	Achilles	Patroclus	Agamemnon	Diomedes
Main Belt																				
Aletheia	3.24	2.61	3.29	2.55	8.72	13	16.7	32.9	45.7	–	2	6.31	6.05	5.66	3.1	2.96	7.63	6.91	8.22	4.02
Ceres	2.95	2.24	2.17	1.33	7.62	12	17.85	31.16	46.5	2	–	5.14	5.42	4.06	4.26	1.03	8.36	4.97	8.18	5.7
Davida	3.38	3.77	3.06	3.91	2.67	6.94	22.8	27.3	51.6	6.31	5.14	–	1.9	2.49	6.02	4.37	6.9	4.84	5.22	7.96
Hygiea	2.87	3.5	3.28	4.12	3.05	6.99	22.7	28.4	51.6	6.05	5.42	1.9	–	3.51	5.29	4.91	5.14	6.52	3.46	7.06
Interamnia	3.69	3.7	2.65	3.25	4.18	8.46	21.8	27.3	49.8	5.66	4.06	2.49	3.51	–	6.61	3.1	8.35	3.77	6.5	8.45
Pallas	2.98	2.95	4.02	3.8	8.23	12	18	33.3	47.8	3.1	4.26	6.02	5.29	6.61	–	4.82	5.34	5.34	6.96	1.99
Vesta	2.87	2.28	1.7	1.15	6.82	11.18	18.8	30.1	47.23	2.96	1.03	4.37	4.91	3.1	4.82	–	8.45	4.11	4.86	6.44

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto	Aletheia	Ceres	Davida	Hygiea	Interamnia	Pallas	Vesta	Achilles	Patroclus	Agamemnon	Diomedes
Trojans																				
Achilles	5.61	6.22	6.92	7.34	7.46	9.74	22.5	32.4	51.9	7.63	8.36	6.9	5.14	8.35	5.34	8.45	–	11.2	5.41	5.79
Patroclus	5.99	5.7	4.71	4.8	6.7	10.5	21.3	27.1	49.25	6.91	4.97	4.84	6.52	3.77	8.14	4.11	11.2	–	6.27	9.98
Agamemnon	5.44	6.13	6.29	7	4.71	6.81	24.4	29.1	53	8.22	8.18	5.22	3.46	6.5	6.96	4.86	5.41	6.27	–	8.13
Diomedes	4.84	4.74	5.85	5.53	10.1	13.7	16.9	35.3	46.9	4.02	5.7	7.96	7.06	8.45	1.99	6.44	5.79	9.98	8.13	–

Use the same table for interplanetary trips to or from a moon: the difference between traveling from Earth to Jupiter or Jupiter's moon Ganymede is negligible on this scale. The distances between different moons around the same body will vary significantly on a daily basis. As a workable abstraction, assume the distance from one planet's moon to another moon around the same planet is (on average) equal to the distance from the planet to the farther of the two moons.

There are millions of asteroids not on the table. If PCs are heading to a made-up asteroid, just decide it has an orbit "similar to Ceres" or some other body, and then add or subtract 0.1 to 0.6 AU to add some variation. For Kuiper Belt objects, assume a distance "similar to Pluto" (or if on Pluto, similar to Neptune), then add or subtract 6d-6 AU for extra variation.

SPACE TRAVEL

Spacecraft are rated for space acceleration (sAccel) in gravities (G) and Burn Endurance in hours. Burn Endurance is how long the spacecraft can sustain thrust, based on how much reaction mass it presently has in its fuel tanks. See *Appendix A* and *Appendix B* for spacecraft design rules and examples.

Deep Space Travel

A spacecraft will generally accelerate for a few hours (or days) until it builds up to a high velocity, and then cut the drive and spend most of the trip coasting. As it nears the destination, it flips end over end, and ignites the drive again, decelerating for the same length of time spent accelerating.

Decide how much of the vessel's current Burn Endurance (in hours) will be used (it's common to leave a reserve, just in case). Then determine the vessel's delta-V (its velocity). Use the formula Delta-V = $A \times B \times 11$ mps, where A is sAccel in G and B is how many hours of Burn Endurance were used. (Alternatively, just decide what percentage of vessel's maximum Burn Endurance was used up, and multiply the delta-V listed in the vessel's performance by that.)

The trip takes about $(26{,}000 \times D)/V + (B/2)$ hours, where D is the distance in AU, V is the delta-V in mps and B is the Burn Endurance in hours. If a spacecraft does not decelerate, it can reach twice that velocity, but, of course, will continue on past its destination.

Escape Velocity: A spacecraft that starts out in orbit around a moon, planet, or the sun needs enough delta-V to escape its gravity and leave orbit. It needs a minimum delta-V equal to 30% of the world's escape velocity. E.g., to leave Earth (escape velocity 7 mps) requires 2.1 mps. (30% of escape velocity is the same as a world's escape velocity minus its to-orbit velocity.)

Continuous Acceleration Voyages: For some very short trips, a spacecraft may wish to accelerate and decelerate continuously, without coasting. The Burn Endurance (and voyage length) = 68 hours × (square root of $[D/A]$), where D is the distance in AU and A is the sAccel.

Reaction Mass Consumption and Burn Endurance: Each hour of Burn Endurance used involves the consumption of an amount of reaction mass equal to the vessel's Reaction Mass Consumption (RMC) rating; see *Appendix A.*

To and From Orbit

Most interplanetary spacecraft never land on planets or sizable moons. Instead, this is left to specially built heavy-lift vehicles and spaceplanes.

To Orbit: A spacecraft trying to reach orbit takes hours equal to $0.046 \times O)/(sAccel - G)$, where O is the world's "to orbit" velocity in mps, G is the world's gravity, and *sAccel* is the spacecraft's sAccel in g. The spacecraft must have sufficient Burn Endurance for the flight.

Space to Ground: A spacecraft can use the same procedure, using thrust to kill its orbital velocity, and then landing vertically.

Spaceplanes: A streamlined delta lifting body or other flight-capable TAV may be able to fly into orbit on worlds with very thin or denser atmospheres. It takes $0.046 \times (O - A) / (sAccel)$ hours, where O and *sAccel* are as above, and A is maximum air speed in mps. The spacecraft must have sufficient Burn Endurance for the flight.

> **When ships to sail the void between the stars have been invented, there will also be men who come forward to sail those ships.**
>
> **– Johannes Kepler**

Aerobraking: A spacecraft orbiting a world with a very thin or better atmosphere can use upper-atmospheric drag to brake its velocity. It must be a streamlined spacecraft (which is piloted down as a glider) that possesses sufficient armor to protect against reentry-heat, or use an attached "aeroshell" heat shield and landing parachute. Aerobraking usually takes 5 to 10 minutes.

Light-Lag and Communications

No faster-than-light communications have been developed. Electromagnetic communications (radio, laser, television) all travel at the speed of light. Sensors are also limited by light speed.

Communications across the solar system often suffer light-lag, a delay between the sending of a message and its reception. To determine light-lag in seconds, multiply the distance in AU by 500.

Information and recordings can be sent across the system, but conversation is impossible. The vast and complex computer net of Earth (the Web) is far less of a factor in the lives of those who live and work in space. Accessing terrestrial Web sites involves dealing with a lag of minutes or hours.

Infomorphs can travel across interplanetary distances in this fashion, with a powerful laser transmitter beaming an encrypted copy of themselves across space. (In the case of ghosts and shadows, anti-xoxing laws require that the original copy be deleted or deactivated, so that only one exists at any time.)

EXTRATERRESTRIAL ENVIRONMENTS

The ***GURPS*** rules govern the actions of people in an Earthlike environment. In space or on other worlds, differences in gravity, atmosphere, and temperature can have a great impact on the way people live, work, and fight.

GRAVITY

Gravity is measured in Gs ("Gees"), with 1 G being Earth-normal gravity. When a character is created, his home gravity should be specified depending on the celestial body, station, or spacecraft he was grew up in, and may be any value from zero to 1 G.

Changes in gravity affect weight, making things heavier or lighter; e.g., an object that weighs 1 lb. under 1 G weighs 0.38 lbs. under 0.38 G. The ***GURPS Basic Set*** assumes 1 G whenever weight is an issue, such as for encumbrance, jumping, and throwing. These must be adjusted if local gravity is different from 1 G.

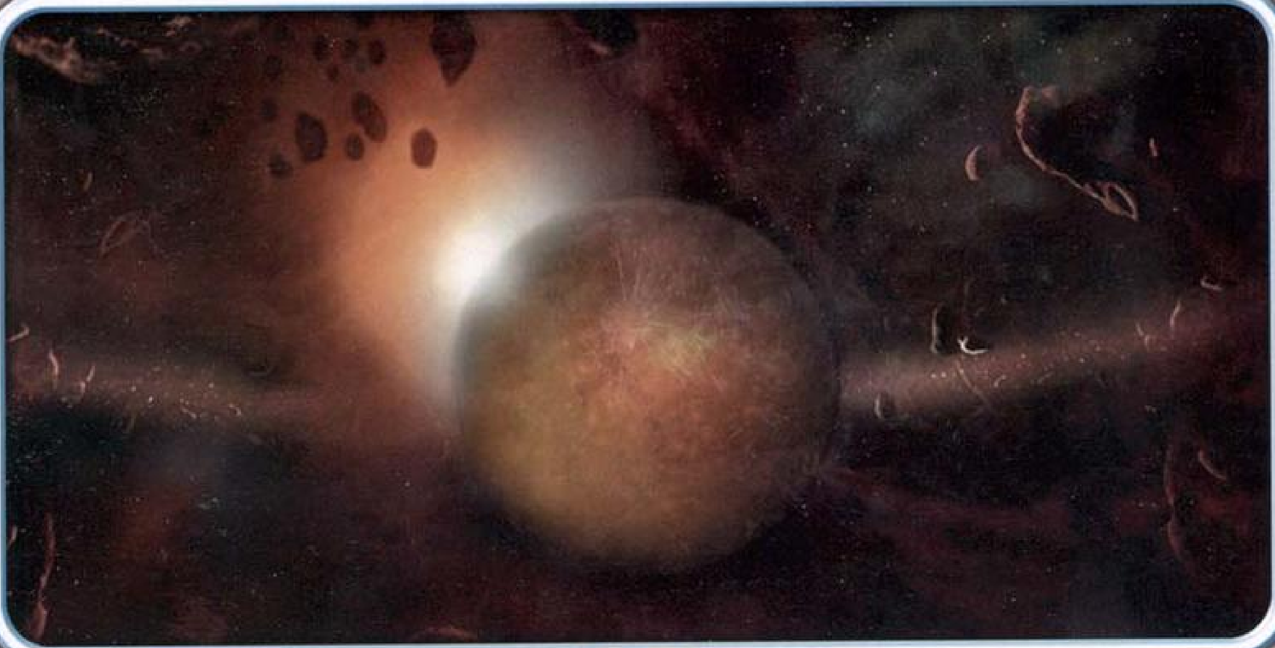
It is vital to know the difference between weight and mass when discussing gravity. Mass measures how much matter you have. Weight measures the force of gravity acting on that matter. Objects have no weight in zero G, but they always have mass. Since gravity is a constant 1 G on Earth, a given mass always has the same weight, so units of weight are often used to describe mass. Remember that this is a shorthand, and that mass is not weight – even when it is measured in units of weight. Be sure you know whether "pounds" or "tons" refer to weight or to mass. Gravity affects only quantities that depend on weight (like jumping distances and the stall speeds of aircraft), not those that depend on mass (like vehicle accelerations and bullet damage).

Characters on Earth, Venus, and some spin habitats experience normal gravity. The giant planets have higher gravity, but characters are not likely to visit them. Most other places in the solar system have low or no gravity. As a result, this section focuses on the special effects of low gravity.

Creatures function best in their native gravity. The amount of change you can tolerate without problems is your G-increment. Most characters (unless they have specific advantages or disadvantages) have a G-increment of 0.2 G. This means that each full gravity change of 0.2 G will have a cumulative effect, as described below. For example, a native of Mars (0.38 G) would suffer a cumulative penalty at 0.58 G, at 0.78 G, and at 0.98 G.

Health and Balance Problems in Higher Gravity

A person suffers a penalty of -1 to DX for each full G-increment the gravity exceeds his native gravity, and -1 to IQ and HT (but not hits) per *two* full increments. These penalties also affect skills based on the attributes. IQ loss represents general fatigue; HT loss represents the heart's having to work harder. This will increase the risk of heart attacks; the GM may have a heart attack occur under higher gravity if a ST or HT roll is a critical failure and a *second* HT roll is then failed. For example, a Martian (native gravity 0.38 G) is at -3 DX and -1 IQ and HT when visiting Earth.



A character with the G-Experience advantage (p. CI125) suffers DX penalties every two full G-increments under or over his native gravity. Thus, a Martian (0.38 G) with G-Experience would be at only -1 DX, IQ, and HT on Earth.

Low Gravity

Low-gravity environments are found on several planets and moons. The major effects are on Move and encumbrance. Multiply a character's encumbrance by the local gravity before calculating his Move score. As well, calculate the change in the PC's own weight and subtract it from encumbrance. This means that encumbrance should be recalculated each time a different world is visited. Encumbrance may quickly reach zero, since the reduction of a character's body weight counts as negative weight for purposes of encumbrance.

SPIN GRAVITY

Space travelers often find themselves in spacecraft or habitats that simulate gravity by spinning. Due to the Coriolis force, spin gravity does not behave quite like real gravity. If a person moves in the direction of the spin, he feels an increase in "gravity"; move in the reverse direction, and gravity drops. Individuals unused to spin gravity are at -2 DX. Double this penalty when jumping, throwing, or using low-speed missile weapons like bows; halve it in an extremely large spin-gravity habitat (spin radius of 3,000 feet or more per G).

Each week in a spin-gravity environment, a character should make an HT roll to adapt to this environment and eliminate the penalties. Those with the G-Experience advantage (p. CI25) halve all penalties; those with the Motion Sickness disadvantage (p. CI82) double all penalties and get no HT roll to adapt.

Example: A 150-lb. human on Mars (0.38 G) would only weigh 57 lbs. He "saves" 93 lbs. If he carries 60 lbs. of gear (which on Mars would weigh 23 lbs.) his actual encumbrance is 23 - 93 = -70 lbs.

Negative encumbrance does not mean negative weight! "Encumbrance" is an artificial concept which includes a character's body weight. "Weight" can never be negative. However, negative encumbrance does give a Move bonus of +1 Move per full 3 × ST pounds of negative encumbrance, to a maximum of +3 Move.

Example: Our 150-lb. human has -70 lbs. encumbrance under Martian gravity. If he has ST 10, he gets +2 Move. Taking advantage of this move bonus requires a DX roll (at a penalty for low gravity; see below) to avoid losing his balance in the unfamiliar gravity. If he misses it, he falls down. Moving at normal rates (as though on a world with standard gravity) requires no roll. Individuals in their native gravity, or characters with the G-Experience advantage (p. CI25), need not roll.

Low gravity has other effects:

Jumping: Multiply this by the ratio of 1 G to your local gravity. Under 0.2 G, you jump 5 times as far. See *Throwing and Falls in Varying Gravities* (p. 56) for similar effects on throwing distance.

DX and DX-based skills: For most purposes (e.g., fighting, throwing things), reduce DX by 1 for each full 0.2 G increment of gravity different from the character's native gravity, unless the character has the G-Experience advantage. In that case, reduce it by 1 per 0.4 G increment. For activities unaffected by gravity, like firing a beam weapon, there is no penalty.

Climbing: Multiply the time required under Earth gravity by the local gravity. E.g., in 0.17 G, climbs take one-sixth as long.

Gunfire: The minimum ST required to use a weapon without penalty increases by 1 per loss of 0.2 G. Projectile max ranges are divided by local gravity. Half-damage range is unaffected.

MICROGRAVITY

"Microgravity" here refers to any gravitational field under 0.1 G. Nothing has significant *weight,* but *mass* remains. Microgravity environments include all asteroids, many tiny moons, and spacecraft boosting at low gravity or spinning very slowly.

Encumbrance is rarely important in microgravity. Long-term HT effects are as per zero-G (p. 55). Thrown objects may go a long way; see *Throwing and Falls in Varying Gravities* (p. 56).

A character's DX in microgravity depends on his Free Fall skill. Whenever a "normal" DX roll is required, roll against Free Fall skill instead. When any DX-based skill is attempted, use the lower of that skill level or Free Fall skill.

Any microgravity maneuver except the most simple requires a roll against Free Fall skill, or the maneuver fails in some way. (Simple maneuvers would include pulling yourself hand over hand along ladders, walking with magnetic boots, or using ordinary hand items. Maneuvers requiring a skill roll include firing high-recoil weapons without flying backward, attempting to throw or catch items, acrobatics, etc.) Effects of failure depends on how badly the roll is missed. If you are tossing a lifeline to a friend who missed his own Free Fall roll and who is now floating off into space, failure means the line misses him. But if your roll is a critical failure, you miscalculate and go floating off in the opposite direction. However, if the PCs all have high Free Fall skills (15+), GMs should dispense with all but the most critical rolls.

Note that in the microgravity of (for instance) an asteroid with a 10-mile diameter, it is easy to throw things entirely away (escape velocity is only 32 miles per hour, or Move 15). If a person can run or jump to reach a speed faster than "to orbit" velocity (70% of escape velocity) they will go into orbit!

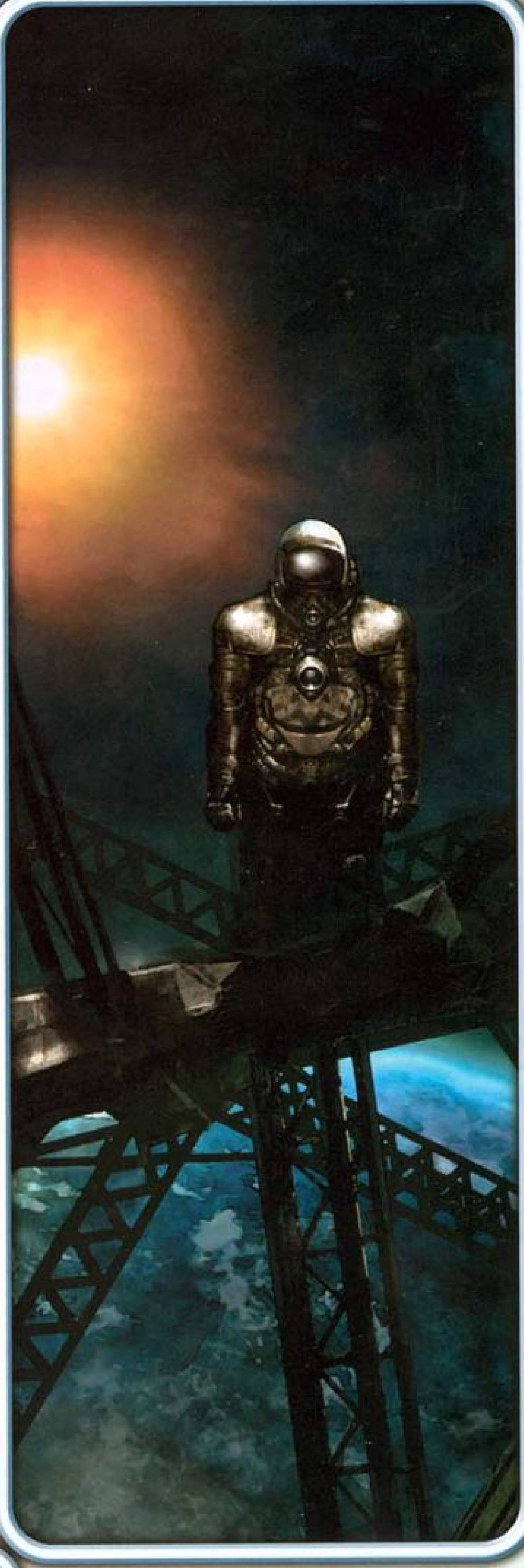
Health Problems in Micro- or Zero Gravity

Lengthy exposure to micro- or zero gravity causes health problems for humans and other species not native to such environments. Over the long term, human immune response degrades (complicated by the fact that some microbes thrive in such conditions, while the effectiveness of antibiotics is reduced), and muscles and bones atrophy (especially in the lower spine and legs) at about 1% per month. The body's efforts to cope with all this lead to cardiovascular and kidney problems.

Characters lacking compensating advantages must roll vs. HT once per month spent in gravity under 0.2 G. Modifiers: +1 for G-Experience; -2 if the character lacks the space, time, or inclination to exercise regularly. Failure indicates the loss of 1 ST and 1 HT. Two-thirds of this loss (round up) will "heal" at the rate of 1 point per week spent in 0.2 G or higher; the rest is permanent. Genetic engineering and biomods can reduce these problems.

Gunfire: Ordinary guns recoil very badly in microgravity; Min. ST is increased by 5, and vented gases give the user a cumulative -1 to hit for each shot already fired, until the user moves away or waits a minute. Guns designed to be used in microgravity or zero G are sometimes available; they vent their gases to the side, which also stabilizes them. Max range is effectively infinite, but projectiles fired on an asteroid or tiny moon will exceed escape velocity and fly off into space once they pass the horizon.

Climbing: Climbing is more like controlled flying. Use the formula given above, but maximum speed is 5 yards per second (you are just grabbing a handhold occasionally to guide yourself). Long climbs use the same speeds as short ones. In zero G, you don't climb at all; see *Zero Gravity* (p. 56).



ZERO GRAVITY

True zero gravity is found only in space, spacecraft, and nonrotating orbital stations. These free-fall situations use the same rules as microgravity, with a few additions.

In free fall, things hang unsupported. A person can move a very heavy object . . . very slowly! And stopping something in free fall is just as hard as starting it. If you have something to push against, you could start a ton of steel moving through space. And if that moving ton of steel traps you against something solid, it will crush you . . . very slowly.

In free fall, thrown objects fly in straight lines (or curved orbits around gravity wells) forever . . . until they hit something.

Speed depends on how hard you can push off from a surface or massive object. You may launch yourself at any speed up to ST/2 yards per second. This requires a full turn in which you can do nothing else, unless you can make a Free Fall roll at -3 to skill. If you succeed, you may do something else with any free hand. (However, all weapons fire is at -3, and high-recoil weapons may send you off in the wrong direction; see below.) Once moving, you continue to move at the same rate until you catch or hit something which stops you.

On the turn you hit or catch something, roll against Free Fall skill. If you miss the roll, you take an extra turn to recover. A critical miss means a hard landing; take 1d-2 damage (armor protects from all but 1 hit of this) and bounce back at half the collision speed, moving until you are stopped. You must make a HT roll or be stunned as well. You may attempt to slow your movement or change direction by throwing an object or firing a high-recoil weapon (any weapon with a Rcl of -4 or worse). Each attempt requires a Free Fall roll. If you succeed, you slow down by 1 yard/second, or change direction by 60°. If you fail, you change direction randomly (GM determines in any sadistic manner). A critical failure starts you spinning; you may attempt a Free Fall -3 roll once per turn to right yourself.

Movement in zero G using vehicles, thruster packs, hand thrusters, etc. is governed by the rules or skills appropriate for the item. Movement along a bulkhead, hull, or other surface in magnetic boots is at standard Move for characters with Vacc Suit skill, Move -1 for those without.

To use fists or a hand weapon (such as a sword) in zero G, roll to hit vs. the lower of Free Fall or the appropriate combat/weapon skill. If you hit, roll vs. Free Fall to avoid being sent floating away by the "equal and opposite reaction" of your strike. It is easier to thrust or jab than to swing: apply a +2 bonus when making a thrusting attack, but a -2 penalty when making a swinging attack. Punches have no penalty; kicks are treated as swings, with a -2 penalty.

Throwing and Falls in Varying Gravities

Throwing Distance: Calculate throwing distance according to the rules on pp. CI10-11 (not the simplified system on p. B90) using the thrown object's weight in 1 G, then divide this distance by the local gravity field for the distance the item can be thrown. For instance, throwing distances are doubled in 0.5 G and halved in 2 Gs. Whatever you throw, remember the "equal and opposite reaction" on the thrower in micro- or zero gravity (see *Zero Gravity*). Under any gravity, the distance you can throw an object straight up is exactly half the distance you can throw it horizontally.

Air Resistance and Throwing: Air resistance can usually be ignored for thrown objects; the ranges given in ***GURPS*** take this effect into account for an Earth-normal atmosphere. However, when throwing things (especially low-density objects) in micro- or zero gravity, it becomes the dominant effect that limits range. Air resistance does not lend itself to simple rules of thumb, but the GM can cite this effect to limit throwing distances in very low gravity. For instance, you cannot throw a ping-pong ball very far in atmosphere, even in zero G. Air resistance is proportional to the density of the air; the thicker the atmosphere, the more significant the effect.

SPACE SICKNESS

Any human or animal entering zero G, aside from individuals native to that environment, must roll vs. Free Fall +2. A failed roll means he becomes "spacesick," disoriented and nauseated by the constant falling sensation. He feels ill and has a -2 to all rolls. He gets one roll (HT or Free Fall, whichever is better) per day to recover. A critical failure on either the initial roll or the recovery roll increases the penalty to -5 and causes the victim to choke as if drowning (p. B91).

Some people are especially prone to this disorder; this is the Space Sickness disadvantage (see p. CI84). A naturally spacesick person is spacesick the entire time he is in zero gravity; he doesn't roll to recover. He must roll vs. HT on entering zero gravity. On a success, all his rolls are at the -2 level; on any failure, he suffers the effects described above for a critical failure: choking and -5 to all rolls.

Other minor health effects of zero G include a distorted sense of smell and taste (-1 on those sense rolls), a puffy face, nasal congestion, and more bathroom visits for the first week or so as kidney filtration rates increase.

Falling Damage: To compute falling damage under gravity other than 1 G, figure the damage that would have occurred under 1 G, per p. B131, then multiply it by the local gravity. E.g., a fall that is computed to do 12 points of damage (before DR is taken into account) would do 24 points of damage under 2 Gs, but only 2 points under 0.16 G.

Falling Objects: Use a similar procedure for determining the damage done by falling objects. Those interested in absolute realism should be aware that *terminal velocity* (the maximum speed at which an object can fall before air resistance) is decreased in low gravity. More importantly, terminal velocity is lower in a thick atmosphere, higher in a thin atmosphere, and unlimited in vacuum! So the *effective maximum fall* (200 yards for most objects; 50 yards for people, who have high air resistance) may vary widely. A general formula: terminal velocity is multiplied by 0.25 in a very dense atmosphere (Venus), 0.5 in a dense atmosphere (Titan), 1.5 in a thin atmosphere (like some space colonies maintained at low pressure), and 2 in a very thin atmosphere (Mars). It is unlimited in trace atmosphere or in vacuum.

VACUUM AND TRACE ATMOSPHERES

Vacuum is the absence of air; a trace atmosphere is so thin it might as well be vacuum, and is treated as such for game purposes. Exposure is not instantly lethal, but suffocation and depressurization will be fatal in a matter of minutes to an ordinary unprotected human or animal.

A human can't hold his breath in vacuum, and might rupture his lungs trying. The only safe way to enter vacuum is to exhale, leaving the mouth open. This allows a person to operate on the oxygen in his blood for (HT) seconds if active, four times that if moving slowly, or 10 times that if passive. Double these times if he hyperventilated first; quadruple them if he did so in pure oxygen. Halve these times if caught by surprise with no time for one deep breath.

Once out of breath, one point of fatigue is suffered per turn; when ST reaches 0, the victim falls unconscious. Four minutes later, he dies. There is a chance of brain damage (permanent -1 to IQ) if the victim is saved after more than two minutes without air; roll vs. HT to avoid this.

Cybershells with Vacuum Support (p. CI40) operate without penalty in vacuum.

Rapid Decompression

If a habitat loses a lot of air due to combat damage or to a meteor puncture, or if a respirator suddenly goes bad, a space traveler may find himself trying to adapt to rapidly falling pressure. Popping ears are a sure sign of a pressure change (IQ +4 to notice for anyone with space experience, IQ for anyone who has received even a basic passenger briefing). If your ears keep popping, pressure is still going down. If the situation is not stabilized quickly, the spacer must get to a pressure suit, escape pod, etc., or be in vacuum. Pressure loss is a terrifying thing. The GM may require all aboard to make a Fright Check (see p. B93); experienced spacers should roll at +4.

Explosive Decompression

Blowout, or explosive decompression, happens when an area suddenly goes from normal pressure to little or none. This could occur, for instance, when a spacecraft loses all its air to a meteor strike, or when someone is tossed out the airlock.

Explosive decompression does not turn its victims inside-out and quick-freeze them. What does happen is that body fluids begin to boil away or sublime. Small blood vessels rupture and mucous membranes dry out. The eardrums pop violently. The victim takes 1d of damage, but does not die until he runs out of breath, as described under *Vacuum and Trace Atmospheres*, above. However, if rescued, he must make the following rolls or suffer the indicated permanent ill effects:

HT +2 for each eye to avoid blindness.

HT to avoid -1 DX due to "bends" from boiling blood (see also p. CII132).

HT -1 to avoid permanently gaining the Hard of Hearing disadvantage.

If the victim is not rescued, then within a few hours his brain will dehydrate to the point where it cannot be read using uploading technology (see p. 167). His body will eventually dehydrate completely; the remaining fragile, powdery husk will weigh only a few pounds. DNA (for cloning) may be recoverable.

Transplants (see p. 161) can cure both blindness and deafness.

OTHER ENVIRONMENTAL DANGERS

The solar system has many ways to kill a person. Here are a few of the more common dangers encountered in space and on terrestrial worlds.

Extreme Heat: Venus and Mercury

The extreme temperatures on Mercury's day side and Venus will quickly kill any unprotected individual. Vehicles, cybershells, or suits require DR 100 and life support or a cooling system; cybershells require DR 100 or Invulnerability (Heat) [75]. For each 10 points of DR (or fraction thereof) the individual lacks, it takes 1d damage per minute; if the vehicle or cybershell has a Size Modifier of +2 or more, multiply by its Size Modifier. If a vehicle's DR is 100 or more, but it lacks adequate life support or a cooling system, damage is 1d per minute, multiplied by its Size Modifier as above. If a device has *both* inadequate DR *and* an insufficient cooling system, these effects are cumulative.

Extreme Pressure: Venus and Gas Giants

The atmospheric pressure on Venus is roughly equal to being 3,000 feet underwater on Earth. Vehicles, cybershells, and suits must be specially designed to operate in the pressure, which usually means DR 100+ and/or the advantage Pressure Support (see below). If a vehicle or suit is not properly designed for Venus, make a HT roll every minute at +2 to avoid a leak. (If HT is not known, e.g., for a suit, assume a value of 12.) For characters, the Pressure Support advantage at the 10-point level or better protects them completely. For characters with 5 points of Pressure Support, or none, roll a Quick Contest of ST each second, with the air pressure having a ST of 100. Pressure Support at the 5-point level gives +10 to this roll. Failure does thrust/crushing damage for ST equal to the amount he lost by. This is reduced by DR effective against all crushing attacks.

Gas giant pressure varies from near-vacuum to many times that of Venus. Rules for operations in gas giant atmospheres will be covered in ***Transhuman Space: Deep Beyond,*** though characters or cybershells capable of surviving Venus can survive in the mid to upper levels of such atmospheres.

Low Pressure and CO_2 Poisoning: Mars

The Martian atmosphere is lethal to normal humans, with both low levels of oxygen and lethal quantities of CO_2 (which produces rapid convulsions, unconsciousness, and death). As a result, ordinary humans must live in habitats or vehicles with life support. A person with the advantages Doesn't Breathe, Oxygen Supply, or Vacuum Support, a respirator or vacc suit, or special genemods or biomods (see *Andraste* biomod, p. 161, or *Yousheng,* p. 117) can venture out without ill effect. Otherwise, a person breathing Martian air loses 1 ST (as fatigue) each second. If he passes out, he takes 1 point of damage every (HT seconds) and will eventually die. A person can hold his breath before losing fatigue; see p. B91. Note: these effects are faster than the CO_2 rules in ***GURPS Space,*** p. 101, which apply to much lower CO_2 concentrations.

Extreme Cold: Vacuum and Trace Atmospheres

Without a significant atmosphere to trap heat, areas in the inner solar system not exposed to sunlight (such as Luna or Mercury at night, or any area in shadow), or just about anywhere in the outer system, are freezing cold. See *Freezing,* p. B130. Insulation is good enough to allow vehicles and colonies to withstand any degree of cold, even on Pluto, as long as there is a power plant to provide heat. A power loss or malfunction doesn't doom the inhabitants immediately; the temperature drops gradually (depending on the size of the area), giving time to make repairs or call for help.

Cryogenic Atmosphere: Titan

Titan's dense pressure (1.5 atmospheres) means visitors can wear unpressurized heat suits, air masks, and oxygen tanks – there is no need for pressure suits on Titan. Its air is unbreathable, but the -300°F nitrogen-methane atmosphere will kill anyone directly exposed to it before they can suffocate. If someone is in a sealed suit, they will still suffer normal freezing effects unless the suit has a life support system.

A human exposed to Titan's atmosphere takes 1d-3 damage *per second.* A HT-6 roll (HT -8 if breathing it) must be made any time damage is taken to avoid shock. On a failure, the victim cannot take action until he is warmed up and receives First Aid. (On a critical failure, his heart stops, and he dies in 3d minutes unless resuscitated by CPR or defibrillation.) Someone in shock still takes damage from the cold and must continue to make HT rolls to see if his heart stops. If a patient recovers from shock, he is conscious but incapacitated for (24 - HT + 1d) hours. If his heart stopped but he was resuscitated, add 3d hours, 6d if defibrillation was required.

The advantage Vacuum Support (p. CI70) protects humans completely.

Underwater

Deep water may be found on Earth, Europa, Ganymede, and Callisto. For immersion at great depths, use the rules for crushing pressure from Venus. Deep, cold water can cause shock if a person is not wearing an insulated "drysuit" or the like. Use the rules for cryogenic atmospheres, but damage is only 1d/minute and the roll to avoid shock is HT rather than HT -6.

RADIATION

Space travelers and colonists may be exposed to radiation due to solar flares, cosmic background radiation, nuclear or antimatter accident, radioactive waste, or attacks by nuclear, radiological, or particle beam weapons. Radiation is especially common in space, away from Earth's magnetic field and thick atmosphere. This is one reason why Titan and Mars, with reasonably dense atmospheres, are more attractive places to settle than other bodies.

Radiation exposure is measured in rads. The more rads you take, the more likely you are to suffer ill effects. The GM should keep track of each character's radiation injuries, noting each dose and the date on which it was received. Each one heals separately from all others received; after a month, it starts healing at a rate of 10 rads per day. However, 10% of the original radiation injury will never heal (except via cell repair using nanotechnology). For example, suppose someone spends a day in a "hot" environment and accumulates a 200-rad dose. After 30 days, that particular injury starts to heal. After another 18 days, at the 20-rad level, that injury stops healing.

> **Skin sensors are reading 22,000 rads. Glad I'm a ghost, or else I'd be toast.**
> **– Susan Xu**

Radiation Hazards

Cosmic Rays: These are generated by interstellar supernovas and contain nuclei of helium, carbon, iron, and heavier elements. They can smash through matter, leaving a train of ionized atoms that can kill a living cell. Unshielded individuals venturing beyond the atmospheres of Earth, Mars, Titan, and Venus may notice these impacts as bright flashes in their eyes every so often, even in total darkness. Cosmic rays inflict 1 rad/week. Only massive shielding protects people. See *Radiation Protection,* p. 60.

Earth's Van Allen Belt: 4 rads/day.*

Fission plant accident: 1,000 rads/hour or more (in close proximity).

Nuclear blast: One-megaton fission air burst or space burst at 2,000 yards: 6,600 rads.

Jupiter's Radiation Belt: 18,000 rads/hour within 125,000 miles of Jupiter (out to the orbit of Thebe), 3,600 rads/hour out to Io, 600 rads/hour out to Europa, 10 rads/hour out to Ganymede, 0.01 rads/hour out to Callisto.*

Solar Flares: See *The Sun,* p. 30.

* Beta radiation levels produced by these belts are orders of magnitude higher, but won't penetrate even thin shielding like a vacc suit or spacecraft hull.

Effects of Radiation on Living Things

Every time a living character accumuluates at least 1 rad of radiation (but no more than once per day for continued exposure to the same source), he should roll vs. HT on the Radiation Effects Table (below), using his current total accumulated dose.

Radiation Effects Table

Accumulated Dose	*HT Mod.*	*Critical Success*	*Success*	*Failure*	*Critical Failure*
1-10 rads	+0	None	None	A (6d)	B
Up to 20 rads	+0	None	A (6d)	B	C
Up to 40 rads	+0	A (6d)	B	C (1 HT)	D
Up to 80 rads	-1	A (5d)	B	C (2 HT)	D
Up to 160 rads	-3	A (4d)	B	C (3 HT)	D
Up to 4,000 rads	-5	A (3d)	B	C (4 HT)	D

Note: The HT modifier applies to all HT rolls that the victim makes.

A: Radiation burns and chronic "somatic" damage. -2 HT for a week. Roll the indicated number of dice; if all come up 6s, the victim develops cancer and dies within a year. Starting a few hours after his irradiation and lasting 7 days, the victim has Low Pain Threshold (see p. B29); if he had High Pain Threshold to start with, it is nullified for the duration. Radiation also causes genetic damage. Human women, who never produce new ova, are more vulnerable than men, who constantly produce new spermatozoa. The offspring of a human female who has taken over 250 rads at *any* time, or a human male who took over 100 rads in the last week, may suffer whatever birth defects the GM wishes.

B: Hematopoietic syndrome. In addition to radiation burns, other effects occur within a day: nausea and vomiting lasting 24-48 hours and loss of 1d ST, DX, and IQ. Afterward, the victim rolls vs. HT daily: on a critical success, he recovers 2 points of ST, DX, and IQ; on a success, he recovers 1 point of each; on a failure, he makes no improvement; on a critical failure, he relapses, losing 1 point of ST, DX, and IQ. As long as the victim's ST, DX, and IQ are depressed, he also suffers from Hemophilia (see p. B28).

C: Gastrointestinal syndrome. In addition to the above effects, other symptoms manifest within 1-3 weeks: permanent loss of the indicated HT as well as all body hair. The victim then starts to lose 1 hit point per day, rolling vs. HT daily; on a critical success, the hit point loss stops and normal recovery can occur (hair grows back). As long as hit points decline, the victim is at risk from opportunistic infections (treat as Weak Immune System, p. CI85). He is also subject to bouts of nausea, vomiting, diarrhea, fever, and prostration; roll vs. HT hourly, or whenever the victim tries to do anything other than rest quietly, to avoid collapse for the rest of the day. If HT goes below 4, the victim's teeth and nails also start to fall out.

D: As C, except that even a critical success on the HT roll won't stop the daily HT loss. Death is certain.

A dose of over 4,000 rads induces cerebrovascular death: Within an hour, the victim loses 2 hit points and 2 IQ, and rolls vs. HT to stay conscious. Repeat every hour. Other symptoms include diarrhea, vomiting, dizziness, low blood pressure, stupor, incoherence, hyperexcitability, loss of coordination, and uncontrollable trembling. Unconsciousness is followed by convulsions and then death (when IQ or HT reaches zero).

Any single dose of 200+ rads also causes sterility and blindness for a few months; a dose of 500+ rads makes it permanent.

Hit Location and Radiation: In some circumstances, only a part of the body may be irradiated. To assess the effects, convert the body part's dose into an *equivalent whole body dose*: divide a dose to the head or limbs by 15, one to the torso by 8, and one to the vitals by 4. A very localized radiation injury may cause the slow necrosis of the body part; over the course of months, the blood vessels fail and gangrene sets in.

Nonhumans and Radiation: The above effects apply to mammals. Effects on other species may vary. For nonmammalian terrestrial life, divide effective dose as follows: by 2 for crustaceans, molluscs, and worms; by 3 for fish; by 4 for reptiles and amphibians; by 5 for avians; by 80 for insects; by 100 for arachnids; or by 1,000 for protozoa. Someone with the Radiation Tolerance advantage (p. 132) reduces dosage the same way. The effects on plant life vary: a tree may die from a 60-rad dose, but grasses can survive 2,000 rads or more.

The advantage Radiation-Resistant (p. 132) reduces the effect of radiation.

Cybershells

Each time a character with the Machine Body advantage accumulates a dose of 100 rads, it must roll vs. HT +4. There is a -1 cumulative penalty per 100 rads accumulated. Failure means it has ceased to function until repaired. Critical failure means it is destroyed and data stored on it is also lost.

As with living things, the Radiation Tolerance advantage (p. 132) divides the effective dose. For example, a cybershell with Radiation Tolerance 100 could sustain 10,000 rads before it had to make a HT roll to avoid malfunction.

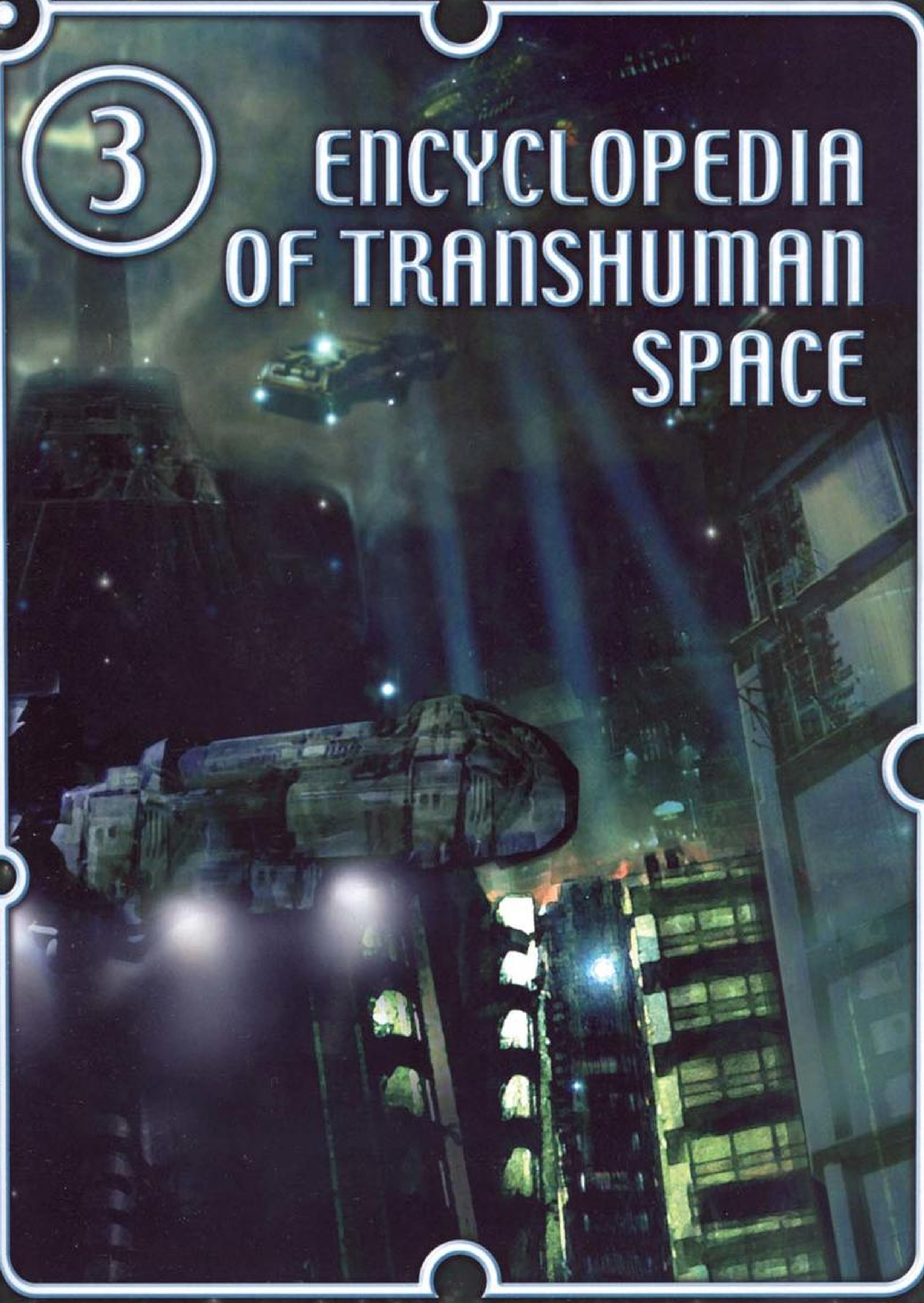
Radiation Protection

Any material between you and the radiation source cuts down on exposure. The thicker and denser the material, the better the protection factor (PF). Divide radiation by PF, e.g., PF 100 means only 1/100 of the radiation penetrates. PF values are listed for spacecraft and vacc suits in the relevant sections (rad-shielded cybershells will have levels of the Radiation Tolerance advantage instead). In most cases, a few yards of ice or rock will provide all the necessary radiation protection; thus, even on radiation-drenched Europa, colonists burrowed under several yards of ice will be fine.

Cosmic rays (also called Milliken rays) and megawatt-power particle beams are heavy subatomic particles traveling at near-light speed. Radiation from either *ignores* ordinary radiation PF; only massively thick shielding (indicated as "cPF") provides PF against them. cPF 1 provides 1 PF vs. cosmic rays or particle beams, and PF 100 vs. solar or radiation belt radiation.

3

ENCYCLOPEDIA OF TRANSHUMAN SPACE



Vatican/TEN: Pope Zachary II, age 72, today announced his decision to eschew rejuvenation during an address to the Pontifical Commission on Human Longevity. He spoke of the inequalities in bionanotechnology between rich and poor nations, and urged an end to economic sanctions against the TSA. His parable of the bioroid and the octogenarian displayed the Pope's wicked sense of humor as well as the sensitivity to pan-sapient rights that has marked his office.

After lunch, the pontiff returned to more serious matters. "Transhumanist ideologies, which degrade Man by reducing him to an object while dissolving basic human rights, are an example of the worst abuse of science," he warned. He renewed the Vatican's firm opposition to the "singular or serial creation of mind without soul, at the service of Faustian ambition," and denounced cybergnosticism, condemning "those who wear the clothes of righteousness even as they bow before digital idols." This was likely aimed at the United States Congress, which next week votes on a health care bill with federal funding for clinics creating mind-emulation backups.

Zachary II's remarks attracted praise from several preservationist groups, including the Human Alliance, but were denounced as biochauvinism by the Church of Seventh Heaven, the largest Christian hyperevolutionist denomination.

CORE TECHNOLOGIES

Just as transistors, antibiotics, and airplanes affected the society of the late 20th century, certain technologies reshaped the world of 2100.

ARTIFICIAL INTELLIGENCE

AIs are artificial intelligence software running on computers. AI refers to the capacity for sentience and intelligent action, but not necessarily self-awareness. AI labor is partially responsible for the increases in global productivity characteristic of the last half-century.

AIs in ***Transhuman Space*** differ from earlier ***GURPS*** concepts in being a function primarily of software rather than hardware. An AI can be housed in a machine body ("cybershell") or a living body controlled through computer implants ("bioshell").

There are three classes of AI:

Nonsapient AIs (NAIs) are capable of sentient behavior and can learn, but lack self-initiative, reasoning ability, empathy, and creativity.

Low-Sapient AIs (LAIs) are capable of self-initiative and a degree of empathy, but lack human-level creativity. Still, it can be hard to tell an LAI from a sapient AI just from conversation. There have been a few rare instances where an LAI (or gestalt of LAIs) evolved into a sapient AI.

Sapient AIs (SAIs) are capable of human-equivalent or higher sapience when run on appropriate hardware. This is sometimes referred to as "self-awareness." Sapient AIs are usually carefully raised by humans or human-programmed SAIs. This socialization process teaches them how to interact with humans. Most SAIs cultivate human-like personas. Sapient AIs almost always have names and many create human-like avatars (software images). Personal ownership of a sapient AI is licensed or restricted in many nations, and copying or modifying them without permission is generally illegal.

There are about as many AIs as people. Approximately one-third of the human population of Earth owns a nonsapient or low-sapient AI who serves as a constant personal companion, inhabiting a home computer or virtual interface (see *Augmented Reality*, below). The population of sapient AIs is smaller: there are fewer than 100 million in existence, primarily due to hardware costs and legal controls.

AIs are programmed to obey the law and their owners. NAIs and LAIs are generally seen as property, but views on sapient AI differ. The Islamic Caliphate considers SAIs to possess souls, and allows them to be citizens. The European Union and some space colonies also grant SAIs "human rights." Most other places disagree, and treat SAIs as property. Sapient AIs created outside the European Union or Caliphate are raised to agree with this view.

AUGMENTED REALITY

This is the overlaying of virtual reality information onto a user's perception of the real world. Its basic element is a "virtual interface": smart glasses incorporating a computer, digital camera, visual head-up display, optical recognition software, cellular modem, and bone induction speaker, all controlled by an infomorph, typically a nonsapient or low-sapient AI.

The system recognizes objects (including faces) and situations, and provides a helpful stream of context-appropriate data, often as audio messages or text boxes in the user's visual field.

The user accesses the system through voice commands or a virtual reality screen (and when necessary, a keyboard) projected in front of him. Usually, the user just tells the AI what he wants it to do, or it anticipates his needs. However, the system's camera can also track the user's finger movements, allowing him to type, move objects, or simulate a mouse, trackball, or other controller in empty air. Virtual interfaces have rendered solid keyboards and computer terminals obsolete. With appropriate programs, the user can manipulate graphic images, or even use his finger as a pen or paintbrush. Infomorphs (AIs and mind emulations) use augmented reality without needing a virtual interface.

Augmented reality is a mature technology in 2100, nearly a century old. The latest advances, not yet ubiquitous, are smarter AIs and replacing wearables with brain implants. Popular augmented-reality applications include:

Memory Augmentation

A typical AR program is a "mug shot" database. Different databases are commercially available or Web-accessible, ranging from the commonplace (famous celebrities) to the job-specific (e.g., a cop may have a database of wanted criminals). Most people also accumulate personalized databases of people they meet or expect to meet, co-workers, and so on. If the virtual interface's camera (or the user's eyes, if he uses a brain implant) spots someone whose face is in the database, the program will automatically display their name and a brief identifier as they come into his visual field, unless told not to do so. Similar remembrance-agent programs and databases can be acquired for other tasks, such as recognizing artwork, wildlife, and vehicles.

Augmented reality can be used with context-relevant data-mining programs that continually search the Web for data with content relevant to the user's current situation and present that information as appropriate. This will augment existing remembrance-agent databases. For example, if a person is encountered who isn't in a user's specific database, his picture and other data still have a very high chance of being in a public file online. True anonymity thus requires either disguise or an appearance nearly identical to thousands of others (fairly common for anyone with a cybershell or bioroid body, for example).

Video and Sensory Processing

Augmented reality can digitally process what the user sees, improving his vision. For example, enhancing the edges in an image helps in face recognition. It can also replace what he sees and hears, immersing him in a virtual reality.

Personal Navigation

In concert with global positioning satellites (GPS) or local embedded transmitters, the user can receive directions overlaid on his visual field, or call up more complex moving map displays. These are available for all urban and most rural areas on Earth and other inhabited worlds or stations. Outdoor maps (or real-time satellite imagery) are accessible from the Web. Building plans may be available for automatic download upon entering a large building such as an office block or mall. (Secure installations would do so only if the individual was recognized as an authorized visitor.)

Virtual Tags

Places, things, and even people can be "tagged" with augmented reality positional overlays called virtual tags ("v-tags"). The v-tag files are usually stored in local networks specific to a location in real-space. The position of tagged objects is updated continuously through tiny GPS or radio-frequency locators in contact with the local network. When someone with an augmented reality system approaches any tagged object, his virtual interface will compare his position in real-space with that of the object; if the user is facing it and within a designated range, his interface will be permitted to download the appropriate information, and he will "see" the v-tag data overlay. In short, a v-tag is a virtual signpost.

It's easy to create v-tags: simply upload an appropriate file. People can attach virtual sticky notes, pictures, etc. to walls, doors, desks, fellow workers – whatever has been coded into the system. Similar v-tags are used in museums, shops, natural parks, billboards, warehouses, etc.

Manufactured goods of all varieties are also v-tagged, with virtual labels that allow access to reams of online data, ranging from ingredients to safety instructions.

Some objects may also incorporate actual sensors to monitor their own status, whether that means checking to make sure milk hasn't spoiled or measuring microstresses in a precision machine. The data from these sensors can be continuously uploaded and available through v-tag access. As all objects transmit positional data, valuable objects may alert humans or software if they are moved without authorization, as well as sending regular updates of their present location – at least, until the signal is jammed or the transmitter removed.

Virtual Tutors

A mechanism (anything from a car engine to a prefab house) may have its dozens (or thousands) of different parts individually tagged with microcommunicators and positional sensors similar to v-tags. Integral databases know where each part goes and virtual interface software can track both the parts and the user's own hand movements, aiding in assembly, disassembly, preparation, or maintenance. For example, when a repair technician (human or machine) walks up to a broken device, the device's components transmit diagnostics to the tech's virtual interface. The virtual interface's augmented reality program locates the 3D position of the object, and overlays real-time step-by-step guides for the technician to follow. Since all the individual parts (and tools) are also tagged, often with additional sensors that monitor things such as stress, current flow, etc., an object-specific "virtual repair manual" can warn the technician if he is taking apart or putting the object back together the wrong way, or if there are internal faults.

The same technology can apply to other tasks requiring rote manual actions using specific processes and components, from building a house to fixing an engine. Each widget, brick, pipe, or module has a chip and sensor in it that knows where it goes and whether it's been installed correctly. Augmented reality has enabled a resurgence in unskilled labor, since these technologies permit untrained individuals to perform complex tasks.

BIONICS

The earliest cybernetic systems were prostheses for disabled or impaired individuals, such as hearing-aid implants and pacemakers. Early in the 21st century, the first systems that linked the user's nervous system with electronics were available, allowing paralyzed individuals to control computers and setting the stage for bionic eyes and advanced limb replacements. At the same time, non-medical applications were also being developed, such as "hands-free" control interfaces for space suits, infantry equipment, and vehicles.

Bionic limbs and organs were common in the 2020s, but are now quite rare, replaced by tissue-engineered transplants easier to grow than bionics were to manufacture. Bionic limbs or organs aimed at *enhancing* a person's abilities are even rarer. It's cheaper and easier just to use gadgets, such as a pair of infrared goggles or a powered suit, and far easier to fix things external to the body if and when they break down. Also, while bionics do allow covert operators to use hidden "surprise" devices, any serious opponent (such as a spaceport customs check) will detect the bionics with sensors. If subtlety is called for, biological modifications or tinier implants are used instead.

BRAIN IMPLANTS

These are cybernetic implants that alter the way a person perceives or thinks. They are tiny – usually pill-sized or smaller. They can be safely implanted or removed by robotic microsurgeons in a few hours. Removal is slightly trickier, as activation of an implant involves weaving a network of nanocommunicators and nano-optical threads through the brain.

About half a billion people have brain implants, mostly in the Fifth Wave cultures. Laws usually require minors to have parental permission before getting brain implants.

Implant Communicator

A radio communicator buried in the head. It can send and receive subvocalizations or, if the user also has a virtual interface, digital data.

Virtual Interface Implant

This is the commonest brain implant, with functionality akin to a standard wearable virtual interface, providing personal computing and augmented reality. It translates brain activity into digital signals that can be transmitted via a microcommunicator, allowing mental control of a computer or other electronic device with similar precision to someone using a mouse, keyboard, or voice input device. While it permits commands to be entered "with the speed of thought," that's about the same speed as a good typist. Devices do not need exotic equipment to be run through a neural interface – any microcommunicator-equipped computer or dedicated computer is usable.

As with other virtual interfaces, it normally houses an infomorph. Most people prefer to share their heads with nonsapient or at most, low-sapient AIs, but it's quite possible for a high-end implant to run a sapient AI or even a mind emulation of another person. In some circles, it's common to have an implant hosting a shadow of a current or lost love, close friend, parent, mentor, or guru. The Pope and Dalai Lama both reacted with horror to suggestions they be brainscanned so that every one of the faithful could have their own spiritual advisor, but other spiritual figures have been less conservative, resulting in so-called xox cults.

Slinks

"Upslink" implants translate the user's sensory experiences, including subvocalized thought, into compressed digital data ("sensory link experience"). This can be transmitted through microcommunicators or implant communicators in real time to someone with a sensory downlink, or recorded on digital media. An upslink could also store data in the computer contained within a virtual interface. Upslinks may be built so slink output is controlled by the user (active upslink) or by someone else (remote upslink); the latter are most often used to monitor convicts or study animal behavior.

"Downslink" implants allow someone to *experience* slink input, either prerecorded or live. Two people who both possess upslink and downslink implants can experience a form of telepathy; a downslinker can read the surface thoughts of an upslinker he is in contact with. Downslinks also allow supervisors to "snoop" on what subordinates with remote upslinks are thinking and doing, although privacy laws usually ban this, at least with humans.

It's possible for a single upslink feed to be retransmitted to multiple, even millions of downslinkers. Such feeds also offer the ultimate form of virtual reality entertainment, although mainstream shows such as news are usually delayed by 1 or 2 seconds, passing through a downslink editor who makes a snap decision to delete anything unpleasant or embarrassing.

Slink recordings can be edited, and such "slinky" media, usually accessed via the Web, is big business, especially for things like porn, cooking, sports, or real or scripted dramas where you "live the experience."

Downslink implants are very common (with over 100 million currently in use); Fifth Wave teens beg their parents for them. Upslinks are usually limited to specific occupations.

Exotic Implants

Implant interfaces, implant communicators, upslinks, and downslinks are all socially acceptable, limited only by their expense and the reluctance of healthy people to undergo brain surgery. More exotic implants are used for psychiatry and mind control. The most sophisticated are *puppet implants,* which allow one mind to control another's body. A puppet implant can allow remote control of a person, but this is difficult due to bandwidth limits. Puppet implants are more effective if the controlling mind is right there – a puppeteer can be an AI integrated into a virtual interface implant.

Implants are capable of synergistic effects. For example, a person might voluntarily accept a puppet implant that is accessible to *multiple* AIs (or shadows) running on a virtual interface computer implant in his brain. If the AIs are under the host's control, this allows him to effectively switch his body between different "personalities" optimized for specific situations.

COMPUTER TECHNOLOGY

Computers come in various sizes, from those installed in microbots or brain implants to mainframe supercomputers capable of running powerful AIs.

Older computers are based on molecular circuits connected by carbon nanotubes. These circuits use bacteria-derived bacteriorhodopsin or other proteins that undergo fast, predictable chemical changes when illuminated. Stabilized into lattice structures, they create nanoscale optical switching systems with higher information densities than silicon-based electronics. These are coupled with holographic memory and data-storage systems that have the advantage of large capacity and instant data search and retrieval.

Newer computers store information in the form of localized conformation changes or charge separations on a macromolecular framework. A macromolecular memory unit the size of a sugar cube can store terabytes of data. Tiny molecular computers control microbots and are used in bionanomachines.

Quantum computers are the cutting edge of parallel information processing. Quantum computers do calculations using atoms in "up" or "down" spin states to represent bits of information. Due to quantum uncertainty effects, each atom does not simply represent one bit, as in a traditional computer. Instead, each "qubit" can be both up and down at once. This allows it to (in a sense) do all possible calculations at the same time until the act of measuring the qubits stops the calculating process. In practice, quantum computers can solve problems that are otherwise extremely time-consuming. The disadvantage of quantum computers is that they need to be heavily shielded to prevent external radiation from affecting them. The first quantum computers were incredibly bulky and fragile, reminiscent of computers in the 1950s. Newer systems are somewhat more compact, but they remain very heavy and limited to large mainframe devices.

Other forms of information processing and data storage may be on the horizon. Some smaller computers use nanofactured "rod-logic" systems that resemble a microscopic version of Charles Babbage's original prototype mechanical computer. At the other extreme, Hawking Industries envisions supercomputers utilizing properties of mini black holes or foamed space-time.

Fusion Power

Thermonuclear fusion involves combining the nuclei of two or more light atoms to produce the nucleus of a heavier atom. Fusion requires tremendous heat and pressure to overcome nuclear forces, but liberates more energy than was used to initiate the reaction. Hydrogen bombs and stars demonstrate the power of fusion.

Several different fusion reactions exist, generally involving the fusion of various isotopes of one or both of the lightest elements, hydrogen and helium. Solar fusion involves a series of reactions that combine hydrogen nuclei (protons) to form helium nuclei, emitting neutrinos, positrons, and electromagnetic radiation (including heat and light) in the process. This type of "proton-proton" fusion, although very efficient, is nearly impossible to achieve anywhere but inside a star, which creates the necessary pressures and temperatures in its core by virtue of its immense size. Human technology uses other means to produce a fusion reaction. In a hydrogen bomb, these conditions are achieved by exploding a nuclear fission bomb as a trigger, but the reaction is over in an instant. A self-sustaining fusion reaction that can power a city or drive a spacecraft is trickier.

The most successful method has proven to be magnetic confinement. Gas is ionized, forming a plasma, which is then squeezed by magnetic fields until it is hot and dense enough for fusion to take place. Fusion research initially concentrated on the deuterium-tritium (D-T) reaction, which required the lowest ignition temperature. This fuses two isotopes of hydrogen into helium, liberating vast quantities of energy in the process. The majority of its fuel is an isotope of hydrogen called deuterium, which is ordinary hydrogen plus an extra neutron. Deuterium is fairly common: in the form of deuterium oxide (heavy water) it forms one part in 5,000 of ordinary water, and can be distilled at some expense using electrolysis. Tritium is a rare radioactive isotope of hydrogen, but can be "bred" by surrounding the fusion reactor core with a jacket of lithium, which transforms into tritium under neutron bombardment.

However, D-T fusion has a disadvantage: much of the energy liberated is in the form of energetic neutrons. Neutrons are dangerous and cannot be directly converted into electrical power. The neutrons must heat water, which produces steam, which drives a turbine, all of which adds extra bulk and cost. Moreover, the bombardment of neutrons irradiates and degrades the structural material of the reactor itself. Even with a careful choice of structural materials, this still means a high maintenance and upkeep cost. Finally, tritium is an essential component in hydrogen bombs, and as such the global use of commercial reactors that require or breed tritium does not help nuclear nonproliferation. As a result, D-T fusion reactors failed to displace other types of power plants on Earth. A few were built as experimental systems, and some are still used in space, especially by the Red Duncanites, but in general, they have been superseded by D-He-3 reactors.

Second-generation fusion reactors fuse deuterium with helium-3, a rare isotope of helium. The He-3 reaction requires higher temperatures to ignite (and thus awaited the development of more advanced magnetic confinement technology), but its main products are charged particles instead of neutrons.

A D-He-3 reactor is environmentally safer, and does not require the same heavy shielding. (There is a tiny amount of radiation produced by secondary reactions, so some shielding is needed.) The charged particles are also easier to convert into electricity. This means a D-He-3 reactor can be lighter, more efficient, and more easily maintained.

The smallest present-day D-He-3 reactors mass several tons and generate megawatts of energy. Building-sized reactors generating a gigawatt of energy are common for cities, producing power that costs a few pennies per kilowatt-hour. D-He-3 reactors are also used in many spacecraft, space habitats, and colonies, powering energy-intensive processes such as agriculture, desalination, heavy industry, electrolysis, and terraforming. Fusion torch drives (p. 178) are variations on these reactors; pulse drives (p. 178) use different technology.

HE-3 MINING

The He-3 concentration on Luna is small, only a few parts per billion. It requires 500,000 tons of raw material (an area of about 1,000 square yards to the depth of four inches) to produce one pound of He-3. Lunar processing plants use automated machinery: robot bulldozers to scoop up the regolith, ovens to bake the soil to 1,300°F, conveyors, and waste processing plants. This is a huge amount of effort, only justified by the worth of each pound of He-3, which can generate staggering amounts of energy when fused with deuterium. With all the other costs of operating a lunar mining base, the profits are not huge. However, a side effect of the processing is that it also yields economically useful quantities of elements such as oxygen and hydrogen, which support other Luna colony projects.

Extracting He-3 from Saturn (and potentially, from other gas giants) is cheaper, as it can be scooped directly out of the atmosphere. Specially designed drone scoop craft dive into the atmosphere and use high-thrust fission rockets to lift gas out to orbiting refineries. The gas is refined into He-3, then shipped via fusion-powered tanker to Earth or elsewhere. A few thousand tons are used annually (a tanker every few months), but demand is expected to double every 15-20 years. Even so, there's enough He-3 in Saturn alone to last centuries, and more in the other gas giants.

GENETIC ENGINEERING

"Gengineering" is the practice of manipulating genes to produce desired changes in an organism. Genetic information, encoded in the molecule DNA, tells a growing organism's cells what proteins to make when, which determines the organism's structure. In 2100, the genomes of humans and many other plants and animals have been thoroughly mapped. More importantly, the protein-coding functions and synergistic relationships of many genes are understood, though not all.

Germline Genetic Engineering

This involves engineering reproductive cells (seeds in plants, eggs and sperm in animals) to alter, remove, or insert selected genes. In a human or other higher animal, the alterations mean the organism will be born with traits it would not otherwise have had. Its genetic heritage – its germ line – is changed. If it reproduces sexually, it passes on some of its new gengineered traits to its children; if it is cloned, it passes on all of them.

Since the 2050s, nanotechnology has brought about a revolution in genetic engineering, permitting the precise creation of designer organisms. Nanomachines similar in concept to retroviruses (hence sometimes called "nanoviruses") are the main tools of gengineering. They pass harmlessly through cell membranes, can hijack cellular machinery using artificial enzymes, and can carry and insert genetic material. They communicate with each other via enzymes to coordinate their operations. Nanoviruses perform two main types of germline gengineering:

Eugenic gengineering, or eugeneering, involves carefully selecting gene sequences already present within a species' genome, but which vary from individual to individual. These might include genes governing simple traits like eye color, or those leaving someone more or less susceptible to a particular disease. Gene combinations also code for various proteins that affect brain chemistry, having subtle impacts on less tangible traits such as intelligence and behavior. Through selecting combinations of genes known to influence specific traits, gengineers can create much the same effect as centuries of animal breeding, but in a single generation. In 2100, eugeneering aimed at fixing perceived faults (such as poor eyesight or mental instability) is known as "genefixing." Eugeneering whose goal is a better-than-average individual is known as "genetic enhancement" and the product as a "genetic upgrade."

Species modification is more radical, but sometimes easier due to its less subtle nature. As DNA is a universal code, genes from one species can be added to another, producing *transgenic* life forms with traits from multiple species. Early 21st-century examples of transgenic entities included bacteria modified with human genes to produce human insulin for diabetics, and crops engineered for greater resistance to pests. 2100-era species engineering can do far more, blending genes from multiple species to produce complex transgenic life forms such as water-breathing humans or talking dogs.

Neogenesis

This is the new frontier of genetic engineering. Neogenesis involves the creation of original life forms. A step up from cut-and-paste species engineering, it has so far brought forth several simple creations morphologically quite distinct from existing species. In addition to various forms of bionanomachines and industrial bacteria, these include exotics such as living bath mats, clothing, and even buildings. Neogenesis gengineers are studying Europan vent life and Titanian organic chemistry in the hope of discovering unique insights into the creation of life.

Proteus Nanovirus

Genetic engineering works on reproductive cells. It is possible to alter the genetics of someone who has already developed, but quite tricky, as many gene combinations have already expressed themselves by creating the parts their DNA told them to build, and then shut themselves off.

A proteus nanovirus is a bionanomachine that can take control of already-differentiated cells. At present, a proteus is limited to making "soft" changes, affecting skin cells, blood cells, genetic material, or the production of specific proteins, rather than "hard" changes that involve reshaping existing organ, muscle, or bone. However, there are rumors of so-called "metamorphosis viruses" under development that can produce more extensive transformations, literally rebuilding a person.

Normal proteus nanoviruses can only survive in controlled conditions and must be tailored for a particular subject. However, some nanoviruses capable of general application, and even spreading through contagion, have been developed. Most are either *very* simple (e.g., skin color) or quite unsafe, often making people sick or worse in the process of changing them. Some military nanoviruses are *designed* to cause massive cell death, or afflict subjects with blindness, sterility, or a "hereditary" disease. The most frightening use the majority of people as carriers, spreading harmlessly until they find someone with certain genetic markers, and then striking.

It is possible to acquire symbiotic "active shield" nano to ward against nano attack, but so far only people in exposed positions (soldiers, those especially at risk to terrorists, etc.) routinely use such technology.

A more benign use of proteus nanotechnology is for full-body cellular regeneration. This process is still fairly new, hideously expensive, and risky, but it can repair nearly any injury or restore the infirm to vigorous youth.

HUMAN GENETIC ENGINEERING

Human beings can be genefixed (see below), genetic upgrades (p. 69), or parahumans (p. 69). All have full human rights, but some governments restrict the gengineering that can be done. Most nations do not permit gengineering that poses physical or mental health risks, stunts or degrades normal human abilities, or encourages criminal behavior. Some places, such as the European Union and Japan, do not approve any modification that might result in a child suffering social alienation: no tails or fur, for example. A waiver is possible for pantropic changes optimized for a colonial environment.

Genefixed Humans

When parents decide to have a child, they usually visit a genetic clinic and assay their own genomes. They often pay for eugenic genetic engineering to fix defects such as hereditary diseases. This is known as being "genefixed." Since the 2030s, genefixing has been gradually extended to apply to tendencies to "flaws" such as lantern jaw, knock-knees, poor complexion, crooked teeth, etc. It is also possible to edit gene sequences tending toward certain mental states, such as lecherousness or poor self-control, or to reduce susceptibility to some mental illnesses. It's generally considered acceptable for parents to do this.

Genetic Upgrades

A genetic upgrade is a person whose genes have been carefully selected (see *Eugenic Gengineering,* p. 66) not only to fix defects but to enhance certain traits (such as appearance, health, or memory). If their clones and descendants are included, upgrades make up about one-fifth of humanity. This is closer to one-third in Fifth Wave countries such as France and the United States, where young people *lacking* upgrades are beginning to be stigmatized.

Genetic clinics offer a variety of "overlay templates," which provide specific genetic traits while leaving most of the parental DNA alone, or which can be merged with known upgrade gene lines. Such templates do not necessarily bring about simple cosmetic changes (a child can be a member of a wholly distinct species even with 98% of its DNA left unmodified). More ambitious parents may choose not to bequeath their genes to their children at all, calling instead for a wholly customized design. This degree of intervention is expensive and is strictly regulated in some countries, but it is usually possible.

Most upgrades come from proven commercial genetic templates ("gene lines"). Selecting one is vastly cheaper than customized eugeneering, since the work has already been done and hidden defects are unlikely to appear. A more subtle advantage is that certain gene lines establish their own subcultures and support groups. Being an Alpha upgrade means you have several million relatives.

Parahumans

A parahuman is a transgenic person (see *Species Modification,* p. 67) whose genome incorporates genes of nonhuman origin, giving him traits that normal humans do not possess. These can range from the strikingly obvious (a coat of fur) to the subtle (a biochemistry adapted to zero gravity).

Each type of parahuman is technically a different species from humanity. With rare exceptions, they are no longer naturally interfertile with other humans or different parahuman species. If a parahuman and a normal human wanted to produce a child, for example, they'd need to blend their DNA via gengineering.

There are several million parahumans in the system. They represent about one-tenth of one percent of Earth's population. However, over one-third of human beings beyond Earth's orbit are parahumans.

Pantropic Parahumans: These are humans whose bodies possess genetic modifications that make them better able to live in a hostile environment. Examples include adaptations for Mars or microgravity, and "econiche" parahumans optimized for harsh Earth environments such as desert or ocean habitats.

Ideal Parahumans: These are humans whose genomes were modified to conform to an individual or group's idea of what the human body *should* be like, or a particular aesthetic vision.

Specialized Parahuman: These are humans physically or mentally optimized for a particular occupation. A small degree of specialized enhancement (for example, a body well-suited for athletic pursuits) is considered ethical, but overspecialization that takes away some of a person's free will or dignity is not.

> **Evolution has become autovolution – and in space there's no stop sign or speed limit.**
>
> **– Chance Mackintosh**

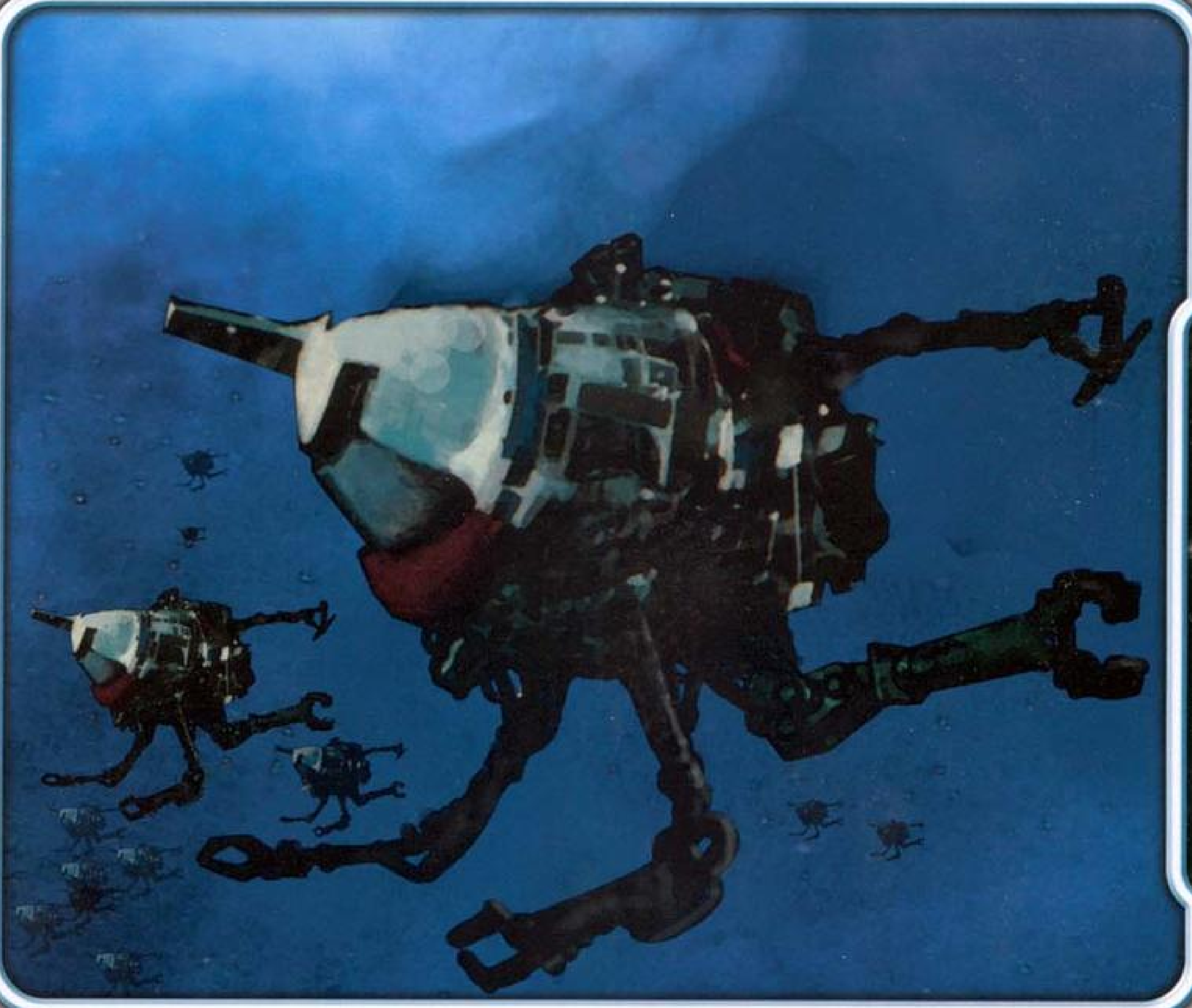
MINIFACTURING

This technology has partially replaced conventional brick-and-mortar distribution and retailing with "print on demand" goods. It is also one reason why small space colonies and moon bases are economically viable.

The basis of minifacturing is advanced 3D printing. The first printers laid down a single 2D layer of ink on a sheet of paper. The new 3D devices deposit a wide variety of materials (such as liquid plastic, conductive and resistive ceramics, metal powders, powder-epoxy composites, or self-assembling nanostructures) in a 3D matrix, treating them with glue, heat, or laser sintering.

The process begins with a digital map of the object's geometry (generated by a computer-aided design program or digitized from an actual object by a 3D scanner). The design is then broken into volume pixel matrices that specify exactly which material the printer should deposit at each point in the design. The 3D printer then prints layer after layer until the real 3D object is formed.

3D printers are able to produce very complex or durable materials (often lighter or stronger than those produced by conventional casting or forging), since it is simple for the layering process to arrange the microstructure of materials for maximum strength. If necessary, larger objects can also be made from multiple smaller modules, laser-cut to shape and welded or glued together. Although a multipurpose 3D printer can be expensive, the primary operating cost is licensing the software. The creation of complicated devices (such as a modern computer) requires programs of high complexity, as their construction can require hundreds of thousands (or more) of individual layers.



CARBON NANOTUBES

These are tiny tubes 10,000 times thinner than a human hair, but incredibly strong for their weight. The fact that they are hollow allows them to function as pipes for transporting atoms and molecules. Since they can be insulators, conductors, or semiconductors, they are used as molecular wires and circuits. They can also serve as tips for atomic force microscopes, or function as molecular bearings and springs in microbots or smart matter. The superior strength-to-weight ratio of carbon nanotubes permits light but extremely strong nanocomposite or nanofiber materials. These are used in products such as vehicle hulls, body armor, and space elevator cables.

NANOTECHNOLOGY

Nanotechnology is a broad range of technologies and products whose characteristic dimensions are less than about 1,000 nanometers. In short, nanotechnology is the engineering of individual molecules and atoms.

How small is nano? A dime is 1,000 microns thick, a human egg cell about 100 microns, a red blood cell about 5 microns, a nerve axon about 1 micron, and a virus about 0.1 micron, or 100 nanometers. DNA molecules are less than 3 nanometers in diameter. Many common proteins are only a few nanometers across. An atom is about 0.1 nanometer.

Nanofabrication

This is the ultimate version of 3D printing (see *Minifacturing*, p. 69). Atomic force microscopes (AFMs) dip tiny probes with tips a few atoms wide into wells of organic molecules (including carbon and DNA). The probes can "engrave" or "write" on a scale of a few nanometers.

Nanofabricators use robot-controlled arrays of thousands or millions of parallel probes to build components for larger microelectromechanical systems, and to create complex nanostructures consisting of a different type of molecules. These include molecular computers, self-assembling "smart ink" used by 3D printers, and various types of nanomachines.

Nanomachines

Molecule-sized assembler robots, made of diamond, that rearrange atoms to build just about anything are still a holy grail, but smart pseudobiological nanomachines exist. These devices are a fusion of microelectromechanics and biomechanics. For example, light-harvesting mechanisms derived from photosynthesis can create the cellular fuel ATP (adenosine triphosphate), the same molecule that powers our own cells. ATP powers various types of nanomachines optimized for different activities. A simple example is a rotor formed out of proteins and metals nestled in a ring of ATPase proteins (an enzyme used to assemble ATP-based nanomachines). These tiny nanomotors perform various tasks, such as powering tiny pharmaceutical factories that manufacture drugs and pump them to tissues requiring them.

Tiny mobile nanobots perform cellular surgery or protect the body against toxins, disease, and other conditions. They recognize cells via their distinct antigens, much the way the immune system does. Their tasks include cell repair, waste product removal, toxin neutralization, and chemical delivery. A patient is injected with a few cubic centimeters of fluid containing millions of nanobots. Those designed to travel the blood are small (2-3 microns), while those intended to traverse tissue, or intestinal or air passages, are several times larger. A typical device has a protein-based frame and is propelled by bacteria-like cilia or flagella. It possesses tiny rotors for molecular sorting and, in some cases, miniature gas or chemical transport vessels. Depending on its designed function, it will use these nanoscale tools to scrub arteries clear of plaque, eradicate cancers or perform on-site repairs to fix cellular damage, or deliver chemical signals. Nanobots designed to operate in the body are usually configured to a particular patient to avoid triggering the body's immune system. Other models are either small or fast-acting enough to be ignored, or have "stealth" coatings that can reconfigure their surface texture to pass as the body's native cells. Nanobots are mostly powered by ATP metabolized from local oxygen and glucose, and do not replicate.

PHARM ANIMALS

Living things can be turned into pharmaceutical "bioreactors" by adding genes that code for commercially useful proteins. Transgenic pharm bacteria and plants are the simplest to create, but animals are often used to manufacture complex products. The chief advantage of animals is their ability to produce more than one protein at a time. They are also easier to control than plants (which are more likely to inadvertently hybridize with other species) and do not require the complex processing vats required by bacteria.

Pharm animals are designed so that products can be extracted safely by tapping or harvesting blood, milk, saliva, urine, eggs, or even cheese. While the gengineering involved is intricate, the maintenance and processing is low-tech, making pharm animals (especially fertile ones) favorites for start-up colonies and developing nations. Paralleling earlier struggles over genemod crops, conflicts often arise between biotech companies who wish to restrict their products' ability to reproduce and customers who want cheap, self-reproducing livestock. Various restrictions are used, such as trademarks embedded into the genetic code, sterilization, or special hormones required before fertility. Similarly, genehacked pharm animals without these restraints sell well on the black market.

Simple pharm animals include cows that produce additive-enhanced baby formula or vaccines, or pigs with human hemoglobin in their blood (to serve as blood substitute). Others possess internal symbiotic microbes that let them produce ready-to-use designer drugs, industrial proteins, or even explosives. Pharm animals were extensively used by the anti-government forces during the Andes War, where genemod goats and llamas manufactured strategic products such as combat drugs, medicines, bomb components, and the spider silk used for arachnoweave armor. Pharm animals used in space colonies often have pantropic modifications to better adapt to extraterrestrial environments.

A variation on the pharm animal is the use of implanted nanofactories to make particular chemicals. Pharm *humans* are also possible, but rarely considered ethical. A few exotic bioroids do have built-in drug factories.

REPRODUCTIVE TECHNOLOGY

"Hey Risa! Did you aug Gordon and Ralph Mackintosh are having a baby?

"No way! You're scraping me. I thought they hated cloning."

"Well, Ralph is. He didn't want to xox his genes, but this is a new Euphrates process. Not cheap, but Gordie's a clade planner, he can afford it. They blend their genes together, then rent an exowomb, you know?"

"Go to! Those two are ***so*** *postal!"*

"Vriff me, sister. An exowomb makes sense, though. Liz had her last sprat that way. Costs more than a surrogate, but it'll never change its mind and want to keep the kid."

"So, do our pair of proud poppas have a name?"

"Chance. Ralph says they're taking one, mixing their genes like that."

– ***Islandia,*** *episode 137 (popular InVid)*

It's possible to have kids the "old-fashioned" way, although most people do a genetic assay to spot defects. If any are encountered, they will genefix (p. 67) the fertilized egg. Other options are:

Cloning: A common procedure; see *Cloning,* p. 162.

Exowombs: A baby need not be raised in a mother's womb. An artificial womb, or *exowomb,* duplicates the maternal environment. This is still expensive, but common for Fifth Wave parents who want kids without pregnancy, or who lack the plumbing – men, infomorphs, etc.

DNA Blending: Two people of the same sex can combine genetic material through gengineering. This is costly ($5,000, 1 week) but not unusual. In the case of males, a female egg is used, but its nucleus is removed. The same process also allows parahumans to have children with members of different parahuman or human species. A more radical procedure, known as chimerization (see p. BIO26), can be used to mix early embryos of completely different species, but this is complex, expensive, and, if mixing human and animal embryos, generally illegal.

Surrogate Mothers: Fertilized eggs can be moved from one mother and (before or after genetic modification) implanted in another one. The procedure is usually simple and safe, dating back to the 20th century. Complications could ensue if the parent is using drugs, nanosymbionts, etc., or if the baby's genetics differ significantly from the surrogate's. In some areas, surrogate wages may be less than the cost of an exowomb, making them a cost-cutting alternative. However, surrogates are illegal in some countries, mostly on ethical grounds.

ROBOTS

Robots are everywhere. Robots range from the simplest of automatic devices to the most sophisticated of artificial intelligences. Some "robots" are even human, in the sense that their "programs" are centered on uploaded human personalities. In addition to industrial robots built into factories, the various classes of robots include:

Microbots

These tiny mobile robots range in size from insect to dust mite. A single microbot has limited utility and intelligence, but a swarm of hundreds or thousands is another matter. Microbots are controlled by pinhead-sized computers running simple programs modeled on insect behavior patterns. A colony of such robots (a "cyberswarm") has intelligence superior to that of any component part, just as an ant colony is an extremely adaptive organism. Many buildings and vehicles have their own hives of microbots living within the machinery or structure, performing routine maintenance and repair tasks. Microbots also have industrial, agricultural, medical, espionage, and military applications. Microbot toy sets exist, such as model farms, zoos, communities, or battlefields, with tiny microbot people, vehicles, or animals. Precocious Fifth Wave kids with cleverly modified microbot construction kits can cause all sorts of mischief.

Cybershells

A cybershell is a machine body larger than a microbot that is designed to house a controlling intelligence. Cybershells range from the size of a mouse on up. Cybershells come in all shapes, from humanoids to things that look like artificial insects, snakes, or vehicles.

A cybershell consists of a frame containing computer, sensor, power, and communications systems and, in some cases, manipulators, means of propulsion, and other gadgets. The solar system is home to about 30 billion cybershells. A minority are androids, but the vast majority have more functional designs. Most house nonsapient AIs, but any infomorph can be used if the cybershell's built-in computer is powerful enough to run it. The latest small computers are powerful enough that a cat-sized or larger cybershell could conceivably be fitted with one capable of housing a sapient infomorph.

Inhabited vehicles or spacecraft capable of being controlled by computer are not called cybershells. The term is applied to the hardware installed within. Thus, a spacecraft may contain several cybershells: its mainframe computers, various work robots, each crewmember's virtual interface, etc.

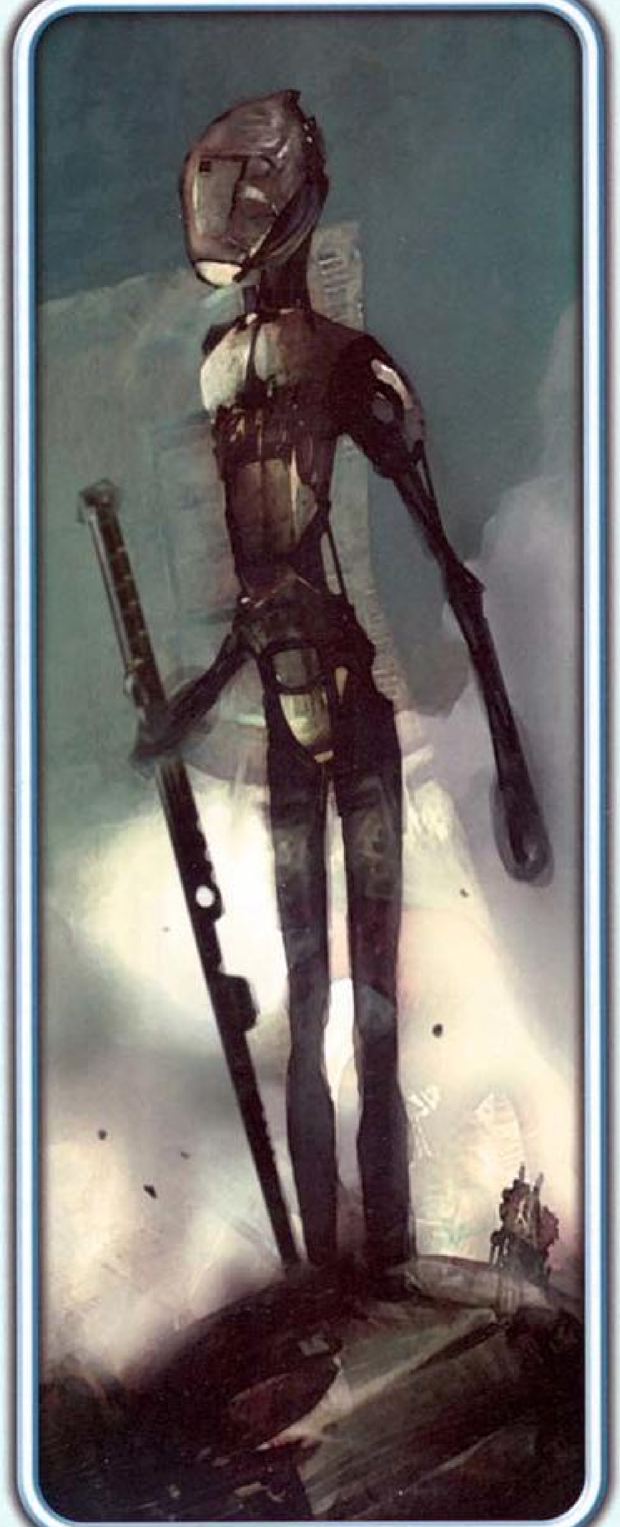
Bush Robots

Just coming into use are fractal-branching ultradexterous manipulator robots, a term usually ignored in favor of "bush robot." A bush robot's arms each branch into multiple "fingers," each of which branches into a set of smaller fingers, and so on, down to micrometer or (theoretically) nanometer scale. Each set of fingers is capable of independent sensing and operation; a "bushbot" can perform complex repairs, or even surgery, without special tools. The amount of computing power required is staggering; therefore, bush robots able to do much more than micromanipulation require sophisticated computer systems.

Bioshells

A bioshell is a living body, often a bioroid (see pp. 76-77) or human clone, whose brain was genetically or surgically rendered decerebrate so it never developed higher functions. It is controlled by an implanted computer housing an infomorph, usually a low-sapient AI, sapient AI, or mind emulation.

The first bioshells created in the 2070s were only fitted with computers running low-sapient AIs or shadows. In the early 2090s, Exogenesis corporation developed a computer small enough to fit in a bioshell body and smart enough to house a sapient AI or ghost, and bioshells became much more popular. There are presently many tens of thousands of them in the solar system. Roughly half host ghosts or sapient AIs, enabling them to experience a more human-like existence. In fact, some bioshells based on human clones have even given birth to human children, a practice that remains quite controversial.



A bioshell's legal status will depend on the infomorph occupying the body. However, bioshells sometimes upset people ("A zombie!"). The creation of bioshells is totally banned in some areas, notably the Islamic Caliphate, and regulated in the European Union, which only allows bioshells to be owned by sapient AIs or ghosts for their personal use. Other cultures, such as the Duncanites, treat bioshells no differently from cybershells.

SMART MATTER

Smart matter products incorporate microelectromechanical systems (MEMS) into their structure. Too small to be seen with the naked eye, these computers, gears, sensor, motors, power systems, and communicators allow a smart matter device to sense and process data, and to react by performing electromechanical actions. Smart matter on a microscopic level produces many of the simpler effects ascribed to a mature molecular nanotechnology. Clothes or footwear can reconfigure itself in a limited but intelligent fashion to ensure perfect fit. Surfaces can vary textures, change color, or even incorporate microscopic brushes to ensure dirt or paint sticks only when it is told to. Aircraft fuselages can alter their aerodynamics to conform to all flight regimes. Layers of smart matter can create self-sealing and, to a degree, self-healing structures.

SPACECRAFT TYPES

Autonomous Kill Vehicle (AKV): A cybershell space fighter. AKVs are small, fast, and heavily armored. They carry various close-in munitions packs such as a kinetic-kill or nuclear-pumped X-ray laser bombs.

Deep Space Operations Vehicle (DSOV): These vessels are built to establish far-off outposts or transport major science expeditions. They have fusion drives and lots of reaction mass, and carry plenty of industrial equipment.

Executive Space Vehicle (ESV): A fusion-drive space yacht, with a few luxury cabins, a staff of bioroids or cybershells, but little cargo.

Heavy Lift Vehicle (HLV): A single-stage laser rocket (sometimes chemical rocket) designed to transport a load of cargo into space.

Heavy Space Transport Vehicle (HSTV): The largest fusion-drive interplanetary transports. HSTVs can carry cargo, but are often equipped with external cradles to sling heavier cargo pods into high velocity trajectories. The HSTV then heads for home, and on the other end, a receiver HSTV intercepts and catches the cargo.

Orbital Transfer Vehicle (OTV): A cheap "space truck" for short-range hops between adjacent orbital facilities, or quick voyages such as Earth orbit to Lunar orbit or L4/L5. Most OTVs use chemical rocket or fission drives. Passenger OTVs lack cabins, instead having airplane-style seating.

Passenger Space Vehicle (PSV): A fusion-drive "fastliner" with lots of cabins and spin gravity.

Remote Survey Vehicle (RSV): A cybershell probe controlled by telepresence or on-board AI. Some use fusion drives; others, slow plasma sails.

Space Dominance Vehicle (SDV): A heavily armored vessel propelled by a fusion or antimatter pulse drive. Armed with particle accelerators, laser irises, and 2-6 AKVs. They often carry a squad of troops.

Space Control Vehicle (SCV): A carrier designed for planetary assaults. They carry a platoon- to battalion-size force, plus a flight of TAVs.

Space Defense Platform (SDP): An orbital battle station. These heavily armored vessels range from small warsats to asteroid-sized monitors. They bristle with weapons, but have little or no mobility. Many are uninhabited.

Transatmospheric Vehicle (TAV): A single-stage-to-orbit cargo or passenger vehicle. Usually powered by chemical or laser rockets, though some TAVs are hybrid craft with air-breathing engines for atmospheric flight.

Utility Space Vehicle (USV): A generic "freighter" used to carry people, haul cargo, prospect, etc. Usually fusion-powered, but older models may use plasma sails or mass drivers.

Work Pod: A cheap one- or two-person spacecraft with manipulator arms and a simple chemical-rocket engine.

SPACECRAFT

"Ship" is out of fashion as a term for spacecraft; "spacecraft," "vessel," and "space vehicle" are preferred. The most ardent exponent of this nomenclature is the USAF, adamant that "ships" are what the U.S. Navy operates.

New spacecraft often cost $100 million or more. A few individuals or partnerships own one, but corporations or governments own most of them. However, even in company-owned craft, a crew might be assigned to a particular vessel and stay with it for several years, only gradually changing in composition as individuals leave and new members are reassigned or hired.

Most spacecraft are propelled by reaction drives. They work on the Newtonian principle that for every action, there is an equal and opposite reaction. A drive throws reaction mass, usually heated to give it extra energy, in one direction, and the reaction accelerates the spacecraft in the opposite direction. On a long voyage, a vessel will accelerate for several hours until it has used up around half of its reserve of reaction mass, then coast at whatever speed it has achieved for several days, and finally spend the other half of its reaction mass to slow down.

Various types of drives are detailed in Appendix A. Most modern interplanetary spacecraft use fusion drives, which accelerate slowly but are efficient enough that a vessel can achieve a high speed over many hours without running out of reaction mass. Fusion drives lack sufficient thrust to overcome the gravity of a decent-size planet or moon, so these deep-space vessels park in orbit and use craft with higher-thrust but shorter-endurance chemical or fission rocket engines to shuttle to and from the surface.

Interplanetary trips typically take a couple of weeks in the inner solar system, or a few months to cross the outer system. Spacecraft are large – hundreds of feet long – but crews are quite small: 2-12 people is typical. Large passenger vessels have rotating sections to provide spin gravity, but most other spacecraft are in zero gravity for the majority of the trip. Crews are zero-G-adapted parahumans, or have nanosymbionts to keep them in good health; passengers take temp nanomods, exercise rigorously, or shut down their metabolisms altogether and spend the trip carried as cargo in nanostasis.

Space crews are busiest at the start and end of a voyage, when the drive is hot and they're near a port bustling with traffic and surrounded by space junk. In deep space, with the drive cold and the vessel coasting, there's less to do. Routine maintenance is usually handled by microbots or cybershells.

Light-lag means they cannot access the Web at real-time speeds, but slinkies, entertainment, mail, etc. can be downloaded. Crews take up hobbies or study, and war crews run battle simulations. A pet, often uplifted, is not uncommon. Some vessels are loose about intracrew relationships, handling any difficulties informally. Others, mostly big companies and the military, have strict "no fraternization" rules (but some crews acquire pleasure bioroids, bioshells, or cyberdolls). A few vessels are family-operated, especially Gypsy Angel craft.

SPACE HABITATS

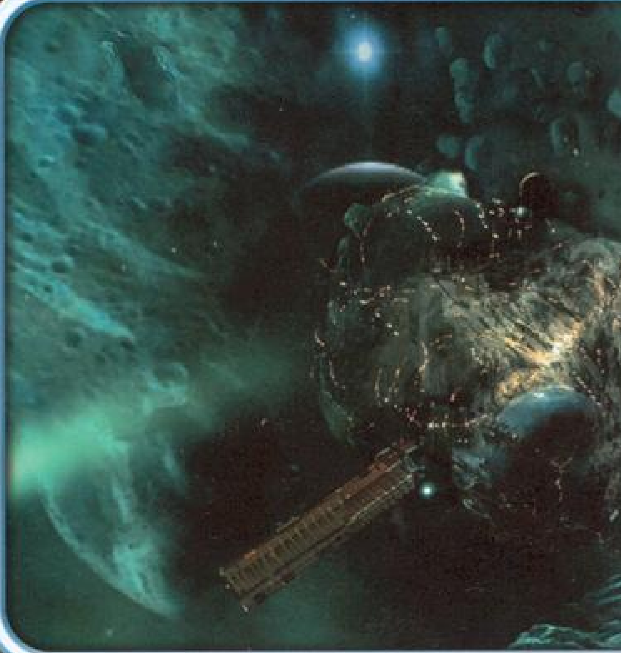
Large, manufactured habitats are built using titanium, aluminum, and steel mined on nearby moons and launched into space by mass driver, or are processed from asteroids. Gravity is simulated by rotation, power comes from large solar collectors or fusion reactors, and a thick shell of slag left over from mining and ore-processing operations provides radiation shielding.

O'Neill Cylinders: These are the largest and most expensive space habitats. They are giant cylinders (or sets of coupled, paired cylinders) a few miles wide and several miles long, rotating to provide Earth-normal gravity. Inside is a complete terraformed environment with park and urban landscapes. An O'Neill cylinder can house a few million people, though current populations tend to be lower. Only a few O'Neill cylinders have been built, such as Islandia in L4.

Stanford Torus: These are smaller than the O'Neill cylinder, but still very large. A typical torus is shaped like a bicycle wheel, with gravity and landscaping on the floor of the outer rim and the spokes serving as elevators that lead to a central microgravity hub. It houses about 50,000 people. Again, radiation shielding is a major expense. A few exist in Earth orbit, L4, and L5.

Bernal Sphere: This is a sphere with smaller attached cylinders. The central sphere may be up to a mile in diameter and rotates; the cylinders do not. The sphere is simple to build, but it only has effective gravity in a strip around its equator, which can be inconvenient. Several spheres have been built, each housing a few thousand people.

Smaller Space Stations: These range from the classic wheel-shaped space station that spins for gravity and incorporates heavy radiation shielding to a much more basic "work shack," "bubble," or "beer can" that lacks much of either. These are usually cylinders or spheres 30' to 300' in diameter and (if cylinders) up to five times as long, often made out of old fuel tanks. The only radiation shielding may be a cramped "storm cellar" for riding out solar flares; the crews either rely on anti-radiation nano or regular rotation.



Asteroid Habitats: See *Cole Habitat* and *Beehive Habitat* on pp. 40-41. Some asteroid habitats exist in the Main Belt or Trojans, but others were constructed from asteroids moved into Lagrange points or planetary orbits. Several dozen exist.

TISSUE ENGINEERING

No one relies on organ donors or clones for spare parts. Advances in tissue engineering have made it possible to grow organs from stem cell cultures in vats or on biodegradable scaffolds, without the need to clone an entire human. Digits, skin, kidneys, livers, ears, noses, tongues, and genitals can be grown in under a month. Independently growing other organs and body parts (like hearts, lungs, eyes, and limbs) is more complex, and takes up to eight months.

Fauxflesh Vats

Gengineered cells from livestock tissue are cultured in growth tanks and supplied with nutrients. This creates a continuously growing biomass of lean meat tissue, which is harvested whenever food is required or it gets too big for its vat. In many countries, fauxflesh has replaced "natural" animal meat, which is often illegal. There is a small but lucrative meat-smuggling trade.

Biogenesis

The most advanced form of tissue engineering is *biogenesis,* which speeds up the process by using nanomachines to rapidly assemble cells into tissue and organs. Biogenesis is more costly but about 4 times faster, taking weeks rather than months. It manufactures a wide variety of designer organisms, ranging from living toys like skullcats (p. 146) to human-like bioroids (see below).

Biological Androids ("Bioroids")

Bioroids are humanoid beings created using biogenesis. Most of the parts are biological, but some are not. For example, a polymer or carbon composite scaffolding is often left in place as the frame on which the skeleton was built. Deeper differences from the human norm will be apparent if their cells are examined. Baseline bioroids are designed to accept artificial chromosomes, with "slots" into which genetic engineers can easily plug specific modules of genes. Much redundant "junk DNA" material, such as transposons, is left out of bioroids. Bioroid tissues typically also contain clusters of nanofactories that produce special proteins that the designers couldn't take time to code into the genes, or which compensate for other shortcuts.

The basic bioroid design is similar to an upgraded human, but with major differences including an upgraded immune system and reduced sleep cycle. All bioroids are sterile (though some female models can serve as surrogate mothers). Many have transgenic modifications that are similar to parahumans, but often more extreme, tailored for a particular occupation. This often extends to brain chemistry. For example, a military bioroid may always feel a rush of endorphins after vigorous exercise, a technical model may be able to go into a single-minded state that lets it focus on a problem, or a pleasure model may go into heat at the slightest provocation. In conjunction with proper training, these tend to result in bioroids who love their jobs.

A newly formed bioroid brain is designed to awaken in a state highly receptive to learning. Brain implants are integrated into the bioroid at this point, allowing it to undergo an intense educational regime that includes virtuality and slinky simulations and vocational training. The "coach" is a personal infomorph hosted by the bioroid's brain implant, often a mind emulation of another bioroid of the same model who can be a big brother or sister to it. It uses a puppet implant to put the bioroid through physical exercises to build muscle memory, administers punishments or rewards (through non-damaging neural stimulation), and, most of all, encourages the bioroid to constantly strive to excel, solve problems, and reason creatively. This produces a trained, fully functioning "adult" in 1 or 2 years. Depending on his viewpoint, he's a model citizen or a fairly clueless workaholic whose life experience and worldview are based on whatever slinkies the company fed him when he wasn't learning job skills.

Bioroids are controversial. People who see them forming in biogenesis tanks or examine diagrams of their skeletons, chromosomes, or nanofactories get a

BIOROID STATUS

Most bioroids were acquired by space corporations who required rapidly expanded parahuman workforces for offworld industrial colonies and stations. In 2080, a scandal at a European Union space factory in Lagrange 4 exposed bioroid abuse. The European Union investigated, and later banned bioroid manufacture as "indentured labor." Others claimed this action reflected E.U. weakness in biotechnology and protected their cyberdoll industry from competition.

In response to criticism, and to protect their market share elsewhere, the "big two" bioroid producers, Xiao Chu and Biotech Euphrates, adopted tougher industry standards. Customers were vetted and certain designs, such as pleasure bioroids, were deleted (except as decereberate bioshells), while others, such as combat models, were restricted to certain government customers. For example, it is presently impossible for private citizens to acquire a Biotech Euphrates "high-lethality AS-2E *Felicia*-model transgenic combat bioroid with special ops warfare training." Instead, a customer would have to settle for an "athletic *Felicia II* transgenic bioroid, with disciplined, team-oriented outdoor survival, paramedic, electronics operation, and self-defense skills."

Bioroids are not bought and sold. If someone wants one, they will pay a bioroid manufacturer to create and educate the bioroid, but the bioroid itself (as opposed to its gene sequences) is *never* the property of the company. A person, corporate, or government entity that pays for the creation and education of a bioroid is its legal guardian until the bioroid reaches maturity. As the bioroid is functional after a year or two, this gives them about 14 years of guardianship. Labor laws generally prevent bioroids from being sent out to work for someone else, but it's legal for the bioroid to work for his guardian's business, just as minors can work on family farms. Most military forces allow bioroid soldiers if they have legal permission from the bioroid's guardian.

Pan-sapients rights activists still denounce the bioroid industry as legalized slavery, and recently the European Parliament has said the same thing.

See also *Bioroid Trafficking* (p. 106).

sense of "living machine." This impression can be reinforced by talking to any young bioroid, who is often similar in personality to every other bioroid of the same model. But a bioroid's brain and biochemistry are basically human; they have emotions, they reason, and they're subject to many of the same hormonal drives as people (although those nanofacs often have a say in it). Those few bioroids who are now 20-30 years old can be quite distinct individuals.

Ubiquitous Computing and Privacy

Computers, sensors, microcommunicators, and tiny batteries are as cheap as toilet paper, and can be imprinted directly onto most surfaces. Processors are invisible, hidden in infrastructure and in almost every device. Humans exist in an invisible web of infrared, laser, and radio signals. Material goods from sneakers to bricks are "smart," capable of exchanging data.

Hungry? Slide a TV dinner in the oven. Your microwave scans the package's nanodot code or v-tag and selects the setting. When it's done, the oven signals your virtual interface, which pages you. Prefer to do your own cooking? Your virtual interface contacts the Web and downloads a menu. If you left the groceries in their original packaging, it scans the labels and checks them off as you pick them up. Can't find something? Ask the fridge. "Pizza shells in the first shelf," it tells you. You pull out the anchovies instead of the pineapple. Your virtual interface scans the label on the can. "Those are anchovies," its inventory agent warns. "Try again."

Ubiquitous monitoring is possible. Tiny "video cameras on a chip" and microbot imaging or audio devices can monitor public spaces. The information can be processed due to the proliferation of AI systems, who may be instructed to inform authorities if anything interesting or troubling occurs: medical emergencies, criminal or subversive acts, etc. Parties such as news media or investigators sometimes employ similar technology on a local scale.

In practice, this sort of "Big Brother" monitoring is restricted to a few states or colonies with authoritarian regimes. Most countries have passed "public privacy" laws that restrict microbot or nanocamera monitoring of public space to certain designated areas, such as around government buildings or during special events. Otherwise, authorities are often required to apply to a judge to place an area (such as a crime-ridden neighborhood) under public surveillance, much as if they were requesting a search warrant. "Black ops" agencies may "forget" to ask for permission, which can lead to scandal when discovered.

Some places permit monitoring but have strict restrictions on when information can be accessed and by whom. Singapore is an example; it has extensive urban surveillance but equally strict laws on when and how humans can access the AI-filtered databases.

A few places, especially those with libertarian societies, have no government monitoring (or no government), but let investigators, concerned citizens, media, and anyone else freely monitor public spaces. Individuals can set up whatever privacy they can afford for their own persons and property. Residents who can get the neighbors to agree with them may declare a "privacy zone," and hire security firms to use swarms of microbot bug-hunters or other anti-surveillance systems to sweep the streets clean of annoying snoops.

Despite these measures and regulations, public privacy is fundamentally limited because just about every person has a virtual interface with a built-in camera capable of recognizing faces and analyzing whom they belong to (see *Augmented Reality,* p. 62). However, at least you can spot them at the same time. Children (and often bioroids) have less privacy, since a parent's ability to monitor dependents is rarely legally restricted. It is common to fit them with biomonitors, give them virtual interfaces whose infomorphs owe a higher allegiance, or give them an allowance with coded limits on how much virtual cash can be spent where. This can result in a barter economy among kids . . .

Workers often have *more* privacy than they did in the 20th century, since a greater percentage are contractors working at home. Even so, as they usually paid for results, rather than by the hour, contractors working in service jobs are often monitored to a greater or lesser degree: supervisory software tracks the number of customers served, people's responses, and so on. Other jobs pair human workers with low-sapient or sapient AI "partners." These may be valued co-workers and even liked, but in jobs where the company provides them, no one forgets whom they actually report to. The degree of AI supervision is often the subject of vigorous contract negotiation.

Ubiquitous monitoring is quite possible in private spaces, although employee contracts and labor law may limit its extent. Secure installations such as military bases or laboratories are often heavily monitored, but there may be strict limits on who has sufficient security clearance to view the reports.

Uplifted Animals

These are animals (such as dogs or chimps) that have been gengineered, surgically altered, or fitted with brain implants to give them communicative ability and intelligence approaching human levels. Most uplifts are borderline-sapient, with reasoning capacities similar to those of a human 5- to 8-year-old.

Uplifts have been created as companions, workers, experiments, curiosities, and even soldiers. They are generally considered animals rather than people, but laws often provide additional protections, with the state having the right to remove an abused uplift. In many areas, such as the European Union, China, and the United States, ownership of a sapient uplift requires a license and (in the E.U.) occasional visits from caseworkers to ensure that the uplift is doing well. Other areas have more lax standards. The South African Coalition, Pacific Rim Alliance, and TSA have few restrictions on uplifts, although normal laws (e.g., regulating owning of dangerous animals and animal cruelty) apply.

UPLOADING AND MIND EMULATION

Memories are encoded within the physical structure of the brain on the molecular level. *Uploading* is the process of copying all this information into a digital form. These upload recordings can be used to create a mind emulation, a computer program that, when run on a sufficiently potent computer, emulates the workings of the original person's mind.

A mind emulation is not merely a recording, but a conscious, self-aware, working digital model of the way a particular living being's brain functions. This requires simulating much of the rest of the body and its environment as well: "naked consciousness" bereft of context rapidly becomes insane.

Mind emulations can be housed in computers contained within bioshells or cybershells. Those without mobile bodies inhabit virtual reality simulations of, at minimum, a room. They are often permitted to access the wider Web itself, allowing them to partake of online virtual realities.

Emulations are usually made of human minds, but animals can be emulated. The legal status of human mind emulations varies between nations: some treat them as artificial intelligences, others as people. There are three types of mind emulation:

Ghost

A "ghost" is created via a destructive uploading (or "brainpeeling") process. A living or newly dead patient (or his severed head) is placed into nanostasis. The brain is removed and carefully sliced by robotic surgeons into multiple tiny segments. Each segment is then scanned by a hypersensitive magnetic resonance imager (HyMRI) or other instrument. The data is used to create a digital reconstruction of the patient's brain configuration, called a ghost.

Brainpeeling is fatal to the original person, so ghosts are controversial. Is it suicide or transcendence? A ghost is a perfect mind emulation, mentally indistinguishable from the original person. Whether it is a "human being" remains in question. People and religions that believe in souls differ on whether ghosts have them. Ghosts require a great deal of computer power to run, equivalent to a sapient AI, but current computers are sophisticated enough that a ghost can be built into a computer small enough to be implanted in a brain.

Most ghosts are the product of individuals who deliberately underwent destructive uploading in order to obtain a form of immortality, often out of a desire to live as a posthuman entity in a superhuman cybershell body or series of bodies. Ghosts have certain advantages: for example, they allow rapid travel across the solar system and beyond, if a receiving station has been set up. Ghosts are also cheaper than full-scale cellular rejuvenation technology. Perhaps most significantly, a ghost can be copied indefinitely. It is against the law in nearly all nations for a person to exist as more than one conscious ghost, but it is legal to create backups of the original or the ghost's current state. Copying either is as simple as copying any other computer program: each backup requires hundreds of terabytes of storage, but that is easy to come by.

The big drawback of ghosts is the question of whether it's really you or just something that thinks it is. The other drawback is that uploading is a complex medical procedure, and once in a while, the operation fails. This usually results in a badly flawed copy or no copy at all.

WHAT DOESN'T EXIST

Dry Molecular Nanotechnology: Modern "wet" nanotechnology uses DNA, self-assembling protein molecules, and gengineered viruses. Nanoscale systems are products of top-down assembly using atomic force microscopes. "Dry" nanorobots working at the molecular level are still confined to the lab.

Force Fields: No fields exist that can stop solid objects or directed energy beams.

FTL, Time Travel, and Gravity Control: No faster-than-light (FTL) travel or communications system, or time-travel technology, has been developed, nor have any machines been built to neutralize or create gravity. Some researchers hope that the study of primordial black holes may lead to breakthroughs.

Reactionless Drives: None have been invented.

Room-Temperature Superconductors: These have been achieved (such as metallic hydrogen wires) but are too fragile, costly, or unstable for widespread use. Robust superconductors that require limited cooling do exist.

Fragment

A "fragment" results from a failed attempt to create a ghost. It has little or no memory of its past existence, but may retain vestiges of its original personality and skills. Fragments are often produced when attempting to destructively upload a person who, after dying, was not immediately placed in nanostasis. If he was frozen using older cryonics techniques, or there was a delay of several minutes or more, then there is a high likelihood of retrieving only a fragment rather than a ghost. In areas where ghosts are treated like people, fragments are treated like people with mental illness or amnesia.

Shadow

Shadows have all the advantages of ghosts, can be run on less powerful computers, and take up less data storage space. They have one big disadvantage: it is clear they *aren't* quite identical to the original.

Shadows are generally created through a nondestructive mind emulation process ("brainscanning"). This process uses nanoprobe monitoring to provide data for a computer model. A shadow is basically a low-sapient AI that has been taught to behave like a person. (A sapient AI has already become a person.) Editing a ghost or fragment can also produce a shadow. This is as much an art as a science, but it will generally produce a more compressed copy suitable for running on a less powerful system.

Shadows are legal in most blocs except the Islamic Caliphate, but are generally treated as property rather than actual people. Multiple copying of shadows is legal in some areas, strongly regulated in others.

NATIONS

There are three great powers and a number of emergent powers. The great powers are China, the European Union, and the United States. The emergent powers are India, the Pacific Rim Alliance, the Islamic Caliphate, the South African Coalition, and the Transpacific Socialist Alliance. There are also hundreds of nations, free cities, and microstates – and some corporations' influence approaches that of nations.

Control Ratings (CR) given are averages. These can vary on a national, provincial, or regional basis according to local laws and community standards.

THE EUROPEAN UNION

The European Union is an economic and political supranational entity whose membership is no longer confined to Europe. Some see it serving as the nucleus of a world state in the distant future. The European Union's members share democratic institutions, an integrated economy and currency, and a common foreign and security policy.

The Treaty of Warsaw in 2041 saw the balance of power in the European Union swing from national legislatures to direct democracy. Today, decision-making and legislation are largely handled by the European Parliament, which is run on cyberdemocratic (p. 89) lines. Executive power still resides in the European Council, which represents the heads of each individual state, although the interests of France and Germany dominate much of the European Union's domestic affairs.

The European Union has the second-largest GNP after China, and a large population. The European Union controls a giant chunk of the world's financial markets and Fifth Wave industrial corporations. On average, the European Union is the most technologically advanced bloc in the system, especially in fields such as nanotechnology, software, robotics, particle physics, antimatter, and black hole research. The European Union lags somewhat in human genetic engineering, due to restrictive legislation.

The European Union moves slowly on many issues because of the requirement for its member states to reach consensus. E.U. politics tend to be dominated by a large class of reasonably well-off elderly voters in four of the most powerful member states: France, Germany, Italy, and the United Kingdom. Tensions exist between the hyperdeveloped core states of Western Europe and Scandinavia and the less prosperous states on its transatlantic, southern, and eastern periphery. E.U. corporations are heavily engaged in trade and development projects in Africa and the Middle East, including large fusion-powered desalination plants.

Dominant memes in the European Union are preservationism (p. 92) and pan-sapient rights (p. 91). Thus, E.U. law does not permit parents to create parahuman children, and is opposed to bioroid manufacture, but at the same time it supports the right of existing bioroids to be free. An ongoing political issue concerns the rights of sapient artificial intelligences to vote, reproduce, and own property. Various laws have granted them a degree of freedom, but they remain constrained.

Quick Facts: European Union

Population: 517 million.

Gross Domestic Product: $46.0 trillion (2100).

Government Type: Federal union of individual countries, which practice diverse forms of open democracy. Several members are constitutional monarchies.

Typical Control Rating: Varies, with CR 2-3 being most typical. The European Union enforces CR 6 on the manufacture of bioroids.

The European Union is composed of multiple member nations including Albania, Andorra, Austria, Bosnia and Herzegovina, Brussels, Bulgaria, Catalonia, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Faeroe Islands, Finland, Flanders, France, Georgia, Germany, Greece, Greenland, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Maritime Union, Montenegro, Netherlands, Newfoundland, Norway, Poland, Portugal, Québec, Romania, Scotland, Serbia, Slovakia, Slovenia, Spain, Sweden, Turkey, United Kingdom, and Wallonia. Several member nations (notably France and the Netherlands) have overseas territories and possessions that are included in the Union or associated with it. Switzerland and the L4 colony of Islandia are closely integrated with the European Union, though not actual political members.

The European Union has multiple Earth-Lunar space habitats, but has not initiated major planetary colonization or terraforming efforts for the purposes of human settlement. However, it pioneered the exploitation of mineral and energy resources on Luna and Mercury, and over a million European Union citizens live and work offworld. To protect them, France, Germany, and the United Kingdom maintain sizable orbital and deep-space military forces, with contributions from other European Union states channeled through the European Space Control Agency (p. 103). The United Kingdom has recently engaged in "police actions" in the asteroid belt, aimed at securing British, Japanese, and African property and disrupting Martian Triad bioroid trafficking. France and Germany perform similar actions in Lagrange 5 and the near-Earth asteroids.

The European Union maintains cordial relations with all major powers and blocs. It has engaged in limited sanctions against the TSA, but France in particular maintains cordial relations with many TSA nations, and French corporations have lobbied strongly to permit continued sales to them. This has led to some minor friction between the European Union and both China and the Pacific Rim Alliance. However, the European Union has traditionally cooperated with PRA member Japan on space development in Luna and the asteroids, and diplomatic squabbles have not been allowed to interfere with business as usual.

PEOPLE'S REPUBLIC OF CHINA

China is the most powerful single nation-state on the planet. It has the world's largest economy, one of the largest populations (1.48 billion), and a mature Fourth Wave technology that boasts some of the world's finest genetic engineers. China possesses a large colony on Mars and smaller colonies elsewhere in the system. Perhaps more importantly, it is internally stable with a strong sense of national destiny.

China is still "officially" Communist, but in name only. The country is still a one-party state with extensive government involvement in business, but it is "market socialism" in which the government's main role is ensuring various basic social services and long-term economic planning. The nation's government officials are primarily business leaders, and their goal is to create a world safe for China, rather than a Chinese world. Chinese authoritarianism is not so much aimed at suppressing internal dissent as in ensuring stable, measured adoption of new technology and new memes. In the early 21st century, China suffered badly from differences between its advanced southern provinces and the less developed interior, and from social problems such as a shortage of women. Today's China works carefully to correct and avoid these and similar problems. Rust China on Mars can be seen as a socioeconomic laboratory that is easily quarantined.

Much of China's success has come from its early support of biotechnology (beginning with GMO crops). Human cloning, parahuman genotypes, and bioroid manufacture all became important elements of the Chinese economy. The government and Chinese corporations offer incentives for parents to raise parahuman children and adopt bioroids where beneficial. This biotech emphasis carries over to the Chinese space program. Vehicles and environmental systems tend to be of old but reliable design, while Chinese astronauts and colonists are often genetically modified or (as bioroids) built for their jobs. The approach seems to work, and has made China an industrial powerhouse even without widespread adoption of cutting-edge Fifth Wave technology or potentially destabilizing sapient AIs, which are rare and tightly controlled.

However, China is a huge nation, and the above generalizations are hazardous. Some regions of China have barely entered the Third Wave information society, while others (notably Taiwan and parts of southern China) are emergent Fifth Wave powerhouses whose skylines are dominated by towering arcologies and whose wealthy entrepreneurs sport the newest brain implants and nanomods.

China has close relationships with Israel, Iran, Pakistan, and Chile, and is relatively friendly with the Islamic Caliphate. These are not alliances *per se,* but rather semi-permanent shared interests that together form a "China Bloc." On Earth, China's major rivals are the TSA, the PRA, and India, and it has a cool relationship with Russia. It is both a friendly rival and partner of the European Union and United States on Earth, but regards America as a strategic competitor on Mars and in the Deep Beyond. The Chinese felt humiliated by the "high-handed" action of the U.S.'s He-3 embargo and their susceptibility to it. Beijing has resolved to close this window of vulnerability.

Quick Facts: People's Republic of China

Population: 1.45 billion.

Gross Domestic Product: $62.3 trillion (2100).

Government Type: Authoritarian technocracy with some democratic features. Certain autonomous regions practice open democracy on a local level.

Typical Control Rating: CR 5, but the autonomous zones are at CR 2, and economic regulation is at CR 2 throughout the country.

The People's Republic of China includes several autonomous zones which have special privileges under national law. The local governments in these regions have almost complete freedom in matters of economic administration and citizens' civil rights. In these zones (certain arcologies, Rust China, the Taiwan Autonomous Zone, the Hong Kong Special Administrative Region, and the Macau Special Administrative Region), the standard of living is higher than the national average.

Quick Facts: India

Population: 1.84 billion.

Gross Domestic Product: $30.0 trillion (2100).

Government Type: Federal republic.

Typical Control Rating: CR 4.

India has a number of regional client states that are closely aligned with its economic and foreign policies, notably Bhutan, Nepal, and Sri Lanka.

> **It is already becoming clear that a chapter which had a Western beginning will have to have an Indian ending if it is not to end in the self-destruction of the human race . . .**
>
> **– Arnold Toynbee**

INDIA

India is still "the world's largest democracy." It is a nation of contrasts; the vast majority of the population lives in an emergent Third Wave economy, but some segments are jump-starting into the Fifth Wave. Serious political, ethnic, and religious divisions remain. While the majority government steers a conservative course, a large nanosocialist party exists, and there is a chance it will win upcoming elections and form a TSA-leaning government. This could have grave implications for both Indian and global stability, and is exceptionally worrisome to neighboring China.

A growing number of Indians live in large scale "bioarcologies" – giant self-contained cities made out of living materials. The first bioarks were completed in the 2080s. Despite one major disaster in 2091 (attributed, perhaps inaccurately, to nanosocialist terrorism), the system proved successful. By 2100, 1.7% of India's population are bioark dwellers, which has helped take the pressure off the Mumbai, Kolkatta, and New Delhi megacities.

India is famous as the heart of Earth's entertainment industry, and Indian companies churn out more InVids than anywhere else. India has extensive orbital facilities, a lunar base, and a Lagrange colony, but no major off-world planetary colonies. It does possess research facilities in the Trojan asteroids.

Quick Facts: Pacific Rim Alliance

Population: 470 million.

Gross Domestic Product: $27.5 trillion (2100 estimated).

Government Type: Military and diplomatic alliance. Most members practice some form of open democracy, although the second-tier or "associate" members include several constitutional monarchies.

Typical Control Rating: Varies widely in the range CR 1-5. Most members have CR 3-4. Australia has CR 1 for most matters, but CR 5 for weapons ownership and use.

PACIFIC RIM ALLIANCE

A military alliance formed as a counterweight to both the People's Republic of China and the Transpacific Socialist Alliance. PRA nations tend to be highly developed Fourth and Fifth Wave democracies with strong national cohesiveness and medium-sized militaries.

The PRA has two "tiers" of membership. The first tier includes those nations that can provide significant economic and military support to the alliance. As of 2100, first-tier members of the Alliance include Australia, Japan, Korea, the Philippines, and the Union of Alberta and British Columbia.

The second-tier, "associate" members include nations which agree to cooperate in mutual defense but which can project little force beyond their borders. Other second-tier nations are those whose association is more diplomatic than military. Second-tier members include Brunei, East Timor, Fiji, Moluccas, Nauru, New Caledonia, New Guinea, New Zealand, Solomon Islands, Thailand, and Tonga.

The alliance's goal is to maintain the status quo in the Western Pacific. International concerns include military and trade rivalry with China, Japanese and Korean upset over TSA information piracy, Australia's support for emergent independent anarchosocialist and democratic microstates in the Indonesian archipelago, TSA support for emergent nanosocialist movements in the second tier, and sometimes prickly relations between the Union of Alberta and British Columbia and its Canadian and United States neighbors.

The PRA is strictly a military alliance, and while members do have strong trade and cultural ties with one another, national rivalries between Korea and Japan and differences in socioeconomic policy between Japan and Australia make any economic or social union unlikely to occur in the foreseeable future. In recent decades, most PRA nations have shied away from space colonization, preferring to invest in underwater habitats, of which the most impressive is Elandra (p. 33). Australian and Japanese scientists were, however, actively involved in Europa exploration. Japan is the PRA nation with the most active space program, with major corporate holdings on Luna, orbital factories, and asteroid bases, often in partnership with the European Union. Korea and Australia also have some orbital factories, commercial spacecraft, and space defense platforms.

TRANSPACIFIC SOCIALIST ALLIANCE

The TSA is an alliance of nations with nanosocialist governments and economies. Its membership has fluctuated; while some nanosocialist states are "one-party democracies," others have joined or left following democratic changes of government – or coups. The TSA suffered a setback during the Pacific War, but nanosocialist ideology continues to spread.

TSA members are mainly nations transitioning between Third and Fourth Wave economies, seeking a shortcut to bootstrap themselves into prosperity. Some are notorious for "pirating" software, nanotech blueprints, genetic templates, or 3D printer programs designed elsewhere. As a result, they suffer under heavy trade sanctions. However, they are not isolated; many large TSA cities benefit from sizable expatriate populations of nanosocialist ideologues from Fifth Wave nations. Several TSA members are in an economic shambles, but others are prospering, notably Bangladesh, Peru, and Indonesia. Mexico has recently elected a moderate infosocialist government (which worries its neighbors), but it is not a TSA member.

TSA military power is not insignificant, due to the large and fairly experienced ground forces of some member states, but its real power is memetic. The TSA's archenemy is China, although various blocs – especially the Pacific Rim Alliance, Islamic Caliphate, and United States – engage in low-level conflicts with TSA-sponsored insurgencies. The TSA is ideologically at odds with the various Duncanite colonies; despite this, they share many of the same enemies, which can be a closer bond.

Quick Facts: Transpacific Socialist Alliance

Population: 1.20 billion.

Gross Domestic Product: $20.6 trillion (2100).

Government Type: Military and diplomatic alliance of nations which share a common ideology. Most member states have authoritarian governments, with few or no democratic institutions.

Typical Control Rating: Varies.

The Transpacific Socialist Alliance is composed of 15 member nations: Bangladesh, Bolivia, Burma, Cambodia, Colombia, El Salvador, Guatemala, Honduras, Indonesia, Laos, Madagascar, Malaysia, Nicaragua, Peru, and Vietnam. The member nations vary widely in population and wealth. In theory, there is no distinction between major and minor members, but the high-population members located in Southeast Asia, and ideological bastion Peru, dominate the alliance.

UNITED STATES OF AMERICA

America is the world's third-largest economy and one of the wealthiest and most technologically advanced. It is at the forefront of interplanetary colonization. U.S. industry is a leader in nanofabrication, uploading, biomodification, fusion drives, human gengineering, and artificial intelligence.

Demographic shifts have seen the United States dominated by a blend of Hispanic and Anglo culture, with Muslims, citizens of African or Asian descent, and econiche parahumans as major cultural minorities. Racism is mostly dead; people routinely change skin color the way they change wardrobes. Internal politics remain the province of the Democratic (now often preservationist) and Republican (increasingly technocratic) parties, with a number of dynamic third parties. Their greatest challenge is the rise of cyberdemocrats and free-city devolutionists. Their struggle to replace the establishment gerontocracy has led not just to noisy politics, but also to violent protests and even low-level insurgency.

The United States has abandoned the role of global policeman, but not retreated into isolationism. Instead, it looks outward toward the new frontiers of Mars and Saturn, while maintaining a hegemonic interest in the Americas. This sometimes leads to conflict with other governments, but the growing influence of Latino culture in America (and the end of the "war on drugs") has facilitated a warmer relationship with the south. In a strange reversal, much of America's new worries regarding crime, illegal immigration, and instability are not with Latin America but with Canada, which has fragmented into multiple nations, some with closer ties to the PRA or European Union.

Pan-sapient rights is a significant social issue in the United States. Current policy is liberal toward ghosts, but treats bioroids and sapient AIs as less than human. Various pan-sapient rights coalitions actively work for more inclusive laws, while some conservative groups would like to ban ghosts as well.

Quick Facts: United States of America

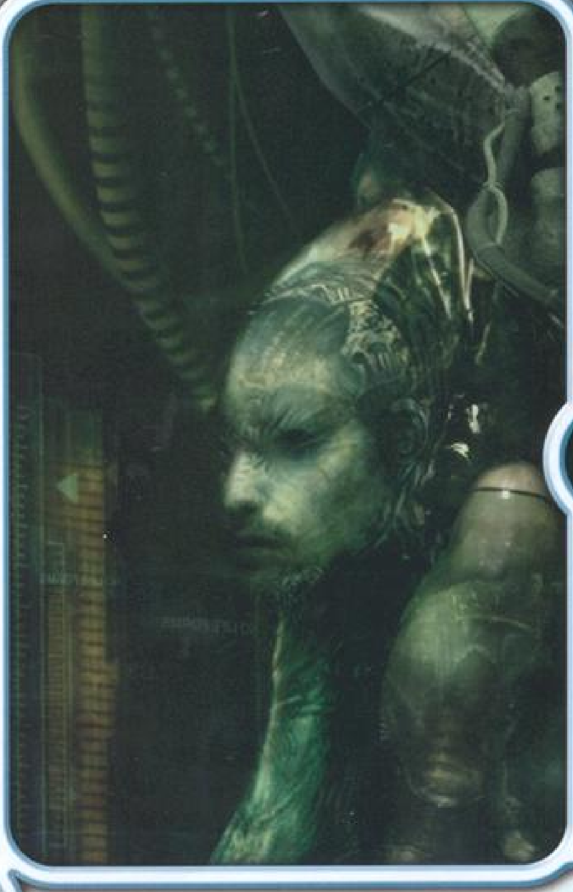
Population: 478 million.

Gross Domestic Product: $43.9 trillion (2100).

Government Type: Federal republic.

Typical Control Rating: CR 3.

The United States leads a much smaller power bloc than it did a century ago. Its closest allies are Ecuador, Panama, a number of Caribbean and Pacific microstates, and (usually) what's left of Canada.



Quick Facts: Islamic Caliphate

Population: 568 million.

Gross Domestic Product: $8.6 trillion (2100 estimated).

Government Type: Military and diplomatic alliance, unified by support of a figurehead religious leader (the Caliph of Medina). All member states are predominantly Sunni Muslim. Several are strong monarchies, and all allow a significant role for Sharia (Islamic law) in internal institutions.

Typical Control Rating: Varies widely in the range CR 2-6. Most members are at CR 4-5.

ISLAMIC CALIPHATE

The Islamic Caliphate is a loose alliance of 13 nations: Bahrain, Comoros, Djibouti, Iraq, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Sudan, Syria, United Arab Emirates, and Yemen. The Palestinian Enclaves (the Gaza Strip and West Bank) are associated with the Caliphate, but are not full members.

The Caliphate is essentially an alliance of the so-called "moderate Arab" states of Southwest Asia. A number of major Islamic states are *not* members, notably Iran, Pakistan, and the Arab states of North Africa.

Oil revenues remain important to the Caliphate's economy, albeit primarily as a source of plastics and fertilizer base rather than energy. The Caliphate has invested heavily in solar power and fusion energy resources, often in partnership with the European Union.

The Caliphate treats sapient AIs as citizens, but is hostile toward ghosts, shadows, and bioshells. The Caliphate has uneasy relations with Israel and Turkey (the latter marred by disputes over water rights), and a rocky relationship with a now-secular Iran.

THE SOUTH AFRICAN COALITION

The Coalition is a cooperative union for the development of sub-Saharan Africa. South Africa is the leading member and provides much of the economic power behind the alliance, but several other members also play independent roles in forming alliance policy. The Coalition includes 13 member states: Botswana, Kenya, Lesotho, Malawi, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe.

Coalition nations are primarily Third and Fourth Wave. The Coalition has received substantial recent investment from the European Union, especially since plans were announced to have the Earth beanstalk touch down in Kenya. South African companies are leaders in inexpensive, low-maintenance biotech, and regularly compete with China for contracts in developing countries.

The Coalition has some joint orbital facilities, but most of its space development belongs to South Africa, which has a couple of orbital factories and commercial asteroid stations. South African companies were lucky enough to fund the early Muldoon expedition, and thus have a share in Hawking Industries. The South African Aerospace Force is a tiny but competent deep-space force.

Quick Facts: South African Coalition

Population: 444 million.

Gross Domestic Product: $6.7 trillion (2100).

Government Type: Diplomatic alliance and free-trade zone. Most members practice more-or-less open democracy.

Typical Control Rating: CR 3-4.

FREE CITIES

There are a growing number of autonomous or semi-autonomous cities. Monaco, Singapore, and the Vatican have been joined by others, notably Koenigsberg in Europe, Montréal in North America, much of Luna, the Islandia space colony, and Port Lowell on Mars. They generally rely on the good will of a powerful neighbor, who accepts the city's autonomy in exchange for benefits its proximity brings. These may be cultural, social, or economic. Free cities often compartmentalize useful activities that might be socially destabilizing if applied over a large area, but which would lead to black markets or crime if no outlet were provided for them. Thus, free cities serve as memetic safety valves: tax havens, free enterprise zones in socialist societies, socialist zones in capitalist societies, data havens, religious centers, "sin cities," or enclaves for unregulated technology. They often act as neutral ground; e.g., Singapore is a meeting place between the TSA, PRA, and China, where they can transact business efficiently, without the necessity for ideological posturing.

NEW NATIONS ON EARTH

The majority of new nations are the result of the strengthening of supranational bodies such as the European Union. This has facilitated the peaceful breakup of existing multicultural states whose regions had strong national or cultural aspirations, since many of the benefits gained as members of their original union or federation are now provided by the superstate. A very short list of the many new nations that exist in 2100 includes:

- Catalonia (formerly part of Spain, an E.U. member).
- East Timor (formerly controlled by Indonesia).
- Königsberg (city-state in the Baltic region, formerly part of the Russian Federation as Kaliningrad).
- Maritime Union (ex-Atlantic provinces of Canada, excluding Newfoundland; now an E.U. member, along with Québec and Newfoundland).
- Republic of the Moluccas (formerly part of Indonesia).
- Scotland (formerly part of the United Kingdom).
- Union of Alberta and British Columbia (ex-Canadian provinces).
- Wallonia (formerly part of Belgium, an E.U. member).

TWENTY POOREST NATIONS

The 20 poorest nations on Earth in 2100 (in ascending order of per-capita GDP) are: Ethiopia, Sierra Leone, Somalia, the Democratic Republic of the Congo, Afghanistan, Eritrea, Liberia, Chad, São Tomé and Príncipe, Sudan, Burkina Faso, Madagascar, Tajikistan, Kiribati, Guinea-Bissau, Djibouti, Haiti, Angola, Mali, and the Republic of the Congo.

THE DUNCANITES

"Here is our dream: a shell of thousands of space habitats, orbiting in the sunspace, drinking Sol's energy like flowers. Our civilization is not resource-limited. Our societies are constantly evolving and diverging. Our goal is knowledge and creation, not wealth or personal power. We are each and every one of us kings of infinite space, growing outward into the cosmos."

– Pierre-Joseph Fox,
Gypsy Angel comet herder and poet

The Duncanites are a loose affiliation of libertarian, nanarchist, and transhumanist outposts in the Main Belt and Trojans, centered on Silas Duncan Station and Freehaven, with settlements and outposts on Callisto, Europa, and even the Kuiper Belt. Cloning, exogenesis, and immigration have swollen the ranks of the original handful of settlers to several thousand people, scattered across more than 40 asteroid settlements. The Duncanites represent the most widely dispersed human culture in history.

Duncanites support themselves through subsistence asteroid mining, comet herding, and human genetic engineering. Duncanite society is based around free-market transactions: the exchange of goods, currency, information, or services without any form of coercion. There are no fundamental laws and no fundamental rights. There are no governments, which Duncanites define as bodies that enforce laws without prior consent and possess ultimate authority over the people. In the Duncanite colonies, corporations or extended families carry out most of the functions of government bureaucracies.

Green Duncanites

These are Duncanites ideologically committed to pantropic colonization and morphological freedom, including those who founded Avatar Klusterkorp and the sponsors of the Europa Project. The major Green Duncanite settlement is Silas Duncan Station (p. 41), on Ceres, but there are outposts scattered through the Main Belt, including a base on Europa.

Red Duncanites

The Duncanites who settled the Trojans are known as "Red Duncanites," named after the spectrum of the dark, carbonaceous asteroids there. Their main settlements are Liang Mountain (p. 45) and Freehaven (p. 45).

They are nicknamed the "Trojan Mafia" due to their willingness to flout international conventions, acting as a clearing house for illicit and gray-market technologies, mostly in the form of software blueprints. Their customers, who often communicate through quantum-encrypted laser channels, include eccentric private citizens, survivalist enclaves, shady corporations, Green Duncanites, criminals such as the Martian Triads, and even some Earth governments. Red Duncanite asteroids can be good places to buy regulated materials such as tritium and antimatter, but they are mainly data havens and banks. In addition to virtual cash and proprietary information, they are said to have backups of celebrity xoxes, orphaned sapient AIs, and emergent intelligences.

China accuses the Trojan Mafia of supplying terrorist groups such as Negative Growth with nuclear materials and other technologies. Recently, China launched punitive strikes against Liang Mountain, killing several people and inflicting millions of dollars in damage. The Red Duncanites have since upgraded defenses and dispersed their facilities over more asteroids. A number of private security operations, known as privateers, have attempted to collect compensation from Chinese facilities in the Main Belt.

Gypsy Angels Collective

A splinter faction of the Duncanites, the Gypsy Angels have a nanarchist society based around a few dozen collectively run spacecraft. They operate freighters (some carved out of ice asteroids) that tie together many of the dispersed asteroid stations. They have business associations with both Xiao Chu and Exogenesis, and may be assisting rogue Exogenesis elements. Unlike the Red Duncanites, they have friendly relations with Rust China, which hires them to send Kuiper Belt Objects toward Mars.

A few Gypsy Angel craft have a reputation on Earth and Saturn as space pirates and smugglers, dating to their activity as the "Pirates of Hyperion" back in the 2080s. Their reputation is more positive on Rust China, where they were praised as heroes for bringing He-3 fuel to Mars despite the U.S. embargo. Some Gypsy Angels have reportedly sent missions into the Oort Cloud.

THE REVISED OUTER SPACE TREATY

The replacement for the old Outer Space Treaty of 1967. The new treaty's key clauses and later protocols include:

Environmental Protection: The treaty prohibits certain industrial processes in Earth-Lunar (and Martian) space, including self-replicating von Neumann machines and large-scale antimatter production.

Homesteading: The treaty contains vague language granting property rights to nations or corporate entities engaged in economic development of particular areas, known as "zones of common courtesy."

Orbital Engineering: Altering the orbit of asteroids, comets, or moons is regulated, especially into Earth-Lunar and Martian space, and flight plans must be filed with international agencies.

Space Propulsion: The treaty prohibits Orion drives (which use external nuclear explosions for propulsion) and regulates the use of fission or antimatter drives within Earth's atmosphere or LEO.

Terraforming: The treaty bans new terraforming operations without international consensus.

Weapons in Space: Deployment of "defensive" weapon systems in space is permitted, but weapons of mass destruction are prohibited.

Although the Revised Outer Space Treaty is broadly accepted as a good compromise, it remains just that; strengthening, altering, weakening, or abolishing it is a major objective of many rival interests. Black holes have fallen through a loophole in the OST, and negotiations on a protocol are in progress.

MEMES

A *meme* is a cognitive or behavioral pattern that can be transmitted from one individual to another; examples include religions, philosophies, languages, morals, traditions, stories, fashions, and fads. Society can be seen as the interaction of multiple memes. Since the individual who transmitted the meme will continue to carry it, the transmission can be interpreted as a replication; a copy of the meme is made in the memory of another individual, making him into a carrier.

Cultural evolution can be modeled through the same principles of variation and selection that govern biological evolution. Just as genes are basic units of biological information and reproduction, memes are units of cultural information and reproduction. For human genes to be transmitted, a generation is required. Memes can replicate in a few minutes, and thus have much higher fecundity. However, the copying-fidelity of memes is often lower: if a story is spread by word of mouth from person to person, then the final version may be different from the original, depending on the means of transfer. It is this variability or fuzziness that distinguishes cultural patterns from DNA structures.

Ever since the invention of songs, poems, writing, and print, memes have benefited from improved copying fidelity and a higher transmission rate. Broadcast transmission (radio, television) allowed individuals with the support of corporations and governments to spread memes at astonishing speed, while digital information networks such as the Internet and the Web empowered individuals to do the same. Digital transmission and storage of memes allows them to be spread without accidental loss of fidelity – but also makes deliberate alteration, analysis, and control of memes far easier.

MEMETICS

"Infosocialism's success is predicated on its memetic virility, not the leadership of any one nation. Communism was the first memetic power bloc on Earth, but failed because it was over two centuries ahead of its time."

– Kyle Porters, ***The Spread of Information***

In 2100, memetics is a subfield of psychology, focusing on the semantic content of ideas and the means by which they can be most efficiently spread through human populations. Memetics is related to such early disciplines as advertising, education, and religious proselytism, but made rigorous by a thorough understanding of how the human brain stores and handles information. Many advanced societies

EDUCATION

Education is seen as a memetic discipline, with teachers using its techniques to propagate knowledge. However, most students interact primarily with simulations and tutors, less so with live teachers. Many areas no longer maintain physical schools, since buildings, real estate, and teachers cost too much. With parents working at home through telepresence, the "babysitting" function of school is less necessary. The Web – and telepresence – keeps kids and young people busy. If they aren't studying, then sensors and infomorphs make it easy to track them. However, "play schools," clubs, and camps for physical education and socialization are fairly common.

have integrated powerful sapient AIs into their decision-making mechanisms. AIs have proven to be a superb tool for tracking the interaction of memes in a culture – and suggesting ways to manipulate them.

The pace of change in late-21st-century society has become so fast that most leaders have consciously begun to use memetics as a technology for social engineering. Part of the challenge for any leader on Earth is to manage one's own society so that it can compete effectively for resources and keep up with the waves of technological change. Most political systems have adapted to doing this through memetic manipulation rather than crude totalitarian mechanisms.

Individuals seek memetic counselors to determine whether they have the particular psychosocial adaptations ideal for success, or at least for their chosen role in society. Corporations do "dirty" mimetic engineering via advertising. Terrorists create "memetic viruses," spreading irrational fears or hatreds as a means to an end. Historically, the best "memetic programmers" were mothers, priests, poets, and marketing directors. Modern memetics makes their techniques "conscious" and widely applicable.

Memetic science rests on two pillars. The first is sapient AI. Capable of natural-language comprehension and "common sense," SAIs can manipulate semantics in a rigorous way, and are well suited to analyzing memes, having a self-awareness of internal reactions and thought processes to a degree unmatched by humans. The second is a thorough understanding of how brain structure affects and reflects learning, due to the research that led to brain implants and mind emulations. Armed with an understanding of how memes mapped to brain structures, memetic engineering came of age in the 2080s, as sapient AIs assimilated prior human research and made new breakthroughs.

Memetics has helped put other social sciences on a more solid grounding. In 2100, memetics is to psychology and sociology as genetics is to biology and ecology. Psychology has finally been accepted as a "hard" science, and there is some hope that sociology will, in time, follow it. Memetics has encouraged people to think of cultures as an essentially contingent phenomenon. This has helped make intercultural clashes slightly less virulent. It is harder to muster the same level of violent fanaticism if one recognizes that one's most closely held ideals are the result of chance and historical evolution, rather than a fundamental revelation. The "meme" meme does not always make people more tolerant, but has created a field for cultural competition that's more like a free market than a war zone. Some sociologists see this as the essential cultural difference between the Fifth Wave societies and the rest of the world.

COMMON MEMES

"Progress is natural. Acceptance of death is a rationalization. The body is a chrysalis. Earth is a cradle. There are no limits. The future belongs to posthumanity."

– Chance Mackintosh, "Shopping for Memes," in ***Posthuman Consumer Review***

Below are some of the more virulent or interesting memes in 2100 and the effect they have had on modern society. Most of the more powerful old memes – such as Buddhism, capitalism, Christianity, democracy, environmentalism, family, Islam, Hinduism, life after death, nationalism, and others – are alive and well in the world of 2100. This section concentrates on new or changed memes.

Alien Contact

Belief in extraterrestrial visitations and alien abductions was sustained by the discovery in 2013 of a habitable planet around 61 Virginis. Continued reports of alien abductions trailed off somewhat in the mid-21st century as humans visited (via telepresence) and colonized other worlds, discrediting memes like "the Face on Mars" and the falsification of the Apollo program.

Following the Pacific War, a new wave of "UFO sightings" and abduction reports began on Mars and later spread to Earth. These centered on the concept that aliens were uploading humans and beaming them to 61 Virginis. A colony of humans, Virginia, has apparently existed there since around 1950, where it will keep mankind safe if destroyed, either by our own hubris or by alien enemies of the Virginians. Tsiolkovsky Farside Observatory was actually a laser transmitter intended to facilitate this operation, but the transmission station has since been removed and is now located on Triton or possibly Pluto.

The discovery of black holes in the Kuiper Belt and Oort Cloud is believed to be connected to the Virginis aliens. The mini-black hole found on Shezbeth was most likely the power core of a hybrid human-alien space station or spacecraft, possibly placed here to defend Earth from other aliens. For the last few decades, the Virginians have provided their human partners with mini-black hole power plants, in payment for the human beings sent out to the stars. The spacecraft lost on Shezbeth was actually human-piloted. Multiple layers of government conspiracies were involved: the Pacific War was a cover for the destruction of Muldoon's observatory just after she discovered the first black hole, to give them time to remove the actual station. Muldoon was *allowed* to find the Shezbeth object itself, since she had already detected it. Hawking Industries now works for the Virginians. This is all part of a plan to prepare us for future intervention.

Amortalism

Amortalists strongly believe that it is socially destructive for people to live forever, as this can result in a stagnant, ultraconservative society dominated by individuals concerned only with continuing their own lives. Amortalist activists often attempt to influence legislation to oppose (for example) state-funded health care plans that include provision for expensive or mass longevity treatments. Amortalists also include religious groups who believe secular immortality is against God's plan or defers heavenly rewards.

A tiny radical group, the Amortality Assassins, takes this a step further, and uses murder and terrorism against those individuals or corporations whom they see as abusing or promoting longevity.

Biochauvinism

This is the belief that biosapient life (humans and bioroids) is inherently more valuable than digital life ("infomorphs"). This meme is widespread and influences public policy throughout the solar system. Local law varies a great deal: an artificial intelligence that is treated as fully "human" in one jurisdiction may be simple property in another. Infomorphs must often take care not to be trapped by unfavorable local laws.

One reason why infomorphs are regarded as less valuable is the ease with which one can make perfect copies of computer software. Another is the deep-seated doubt, harbored by many people with religious or spiritual convictions, that a machine can have a soul and that consciousness is a mechanistic process.

The concept of the singularity is often used by biochauvinists to suppress the rights of sapient AIs, by fostering a fear that they will be the "in" group that survives the singularity and that everyone else will be what's cast off.

Colonialism

The pioneer spirit is alive in the solar system, freed of the negative connotations of taking away someone else's land. Mars, the asteroid belt, underwater, and elsewhere provide a chance for nations to peacefully exercise their aspirations and for individuals to make new lives. Ideological groups (see *Plymouth Rock Society,* p. 98), corporations, governments, or family members who have already arrived and made good often subsidize individual colonists. There are usually conditions. For example, a skilled mining engineer who signs a one-year contract with System Technologies can emigrate to Mercury for free, and the Elandra administration offers allowances to anyone who accepts biomod gill implants and agrees to have aquatic parahuman children.

Cyberdemocracy

A long-standing problem of democracy is the role of money in the political system. Many attempts at reform have been mounted. In recent years, however, a new political concept has become increasingly popular: *cyberdemocracy.*

Some political offices (usually in large legislatures rather than senior judicial or executive positions) are no longer filled by popular vote. Instead, one eligible citizen is chosen at random to fill each office. He holds office for a fixed term, and then returns to private life. Office holders may select a human staff and receive advanced AI systems to advise them. The role of the AI staff in assisting rookie politicians has given it the name cyberdemocracy.

The system was first tried in Switzerland in the 2070s. In 2100, the European Parliament, the national parliament of Finland, and the lower houses of the Austrian and Swiss parliaments all use cyberdemocratic systems. In Europe, cyberdemocracy was adopted as a natural evolution of representative democracy, but in the United States, its supporters are often associated with various extremist groups involved in violent antigovernment insurgency.

Cybergnosticism and Neo-Gnosticism

This is the belief that that the physical world is impure or inefficient, and that existence in the form of "pure information" is better and should be pursued. Cybergnostics often use brain implants, and have been known to modify their bodies and those of their children to reduce temptations of the flesh. Cybergnostic transhumanists sometimes practice destructive uploading. There are many cybergnostic cults, some with thousands of members. For example, the Neo-Gnostics pursue purity of the body as the route to a pure soul, genefixing their children to reduce tendencies toward promiscuity and gluttony.

Green System

"Green" is an obsolete Earth term for "environmentalist." Today, it refers to people who support the rapidly accelerated terraforming of Mars or other celestial bodies: the Green System. Greens believe humans have the right and perhaps the responsibility to bring life to a dead solar system. This is often linked to the *final anthropic principle,* that life and intelligent life are not only necessary to the universe, but are destined to pervade and dominate it. Many people now living on Mars support the Green System meme.

Hyperevolutionism

Hyperevolutionists believe that humans have a responsibility to evolve themselves into transcendent beings through nanotechnology or uploading for the betterment of humanity as a whole. Hyperevolutionists have been in the forefront of the ethical transhumanist movement since the 2080s. Many believers have undergone radical transformations aimed at increasing their intelligence. Some of their funding has come from the Algernon Foundation (p. 98).

A branch of hyperevolutionism that has almost eclipsed the secular movement is Christian hyperevolutionism. Founded in the 2060s by Dr. Ramen Garcia, it is inspired by philosophers like Teilhard de Chardin and Frank Tipler. Christian hyperevolutionists see God as an infinity of information formed during the collapse of a closed, life-pervaded universe into a single point. As the universe collapses, the speed of information processing increases, allowing the creation of the ultimate being, God. Christianity represents a presentiment or message from this future God. The Christian hyperevolutionists' ultimate goal is to fulfill God's plan by discovering how to engineer a local collapse in space-time ("the second coming"), which they see as requiring humanity's prior evolution of information-dense posthuman intelligence.

There are a number of Christian hyperevolutionist colonies and monasteries in space; the largest is Seventh Heaven in Lagrange 5.

Libertarianism and Anarchocapitalism

These are socioeconomic philosophies based on the primacy of individual rights and responsibilities. They hold that the only agreements that should bind an individual are those contracts into which he freely enters, and that unregulated economic activity in a society that cherishes both personal freedom and individual property rights will lead to an efficient economy and greater prosperity. They differ from traditional conservatives and modern liberal democrats in advocating both fiscal and personal freedom. If someone's actions don't harm others, then he should be free to do as he likes. They disapprove of taxing people to pay for social welfare, but believe that a free, untaxed economy will create plenty of jobs, with wealth left over for charity and freedom to move to where work can be found.

There are various contending schools of thought in this tradition. Two that are gaining popularity in 2100 are:

Minarchists believe that the largest justified government is one that is limited to protection of individuals and their private property against physical invasion; government should provide police, a constitution, courts, and national defense only. Minarchists are a growing "third party" in the United States, and have held power in Australia and in the Union of Alberta and British Columbia.

Anarchocapitalists believe that any government is too much government. Security and court services can be offered in the marketplace by competitive firms. Laws develop through custom, precedent, and contracts (much as the British legal system did). Private police and judges negotiate agreements in advance to prevent arrests turning into warfare. Silas Duncan Station and several other Duncanite stations are functional anarchocapitalist societies. See also *Nanarchy,* below.

Mechanimism

Simple computer systems (on the level of a child's playmate) are tiny and inexpensive, making them ubiquitous. Mechanimism is the popular name for the animistic tendency to treat common gadgets as "alive" and, in some sense, aware. Common tools and objects have embedded computers, often powerful enough to run natural-language interfaces and linked to a local household or office network. As a result, some people have grown up with the idea of constantly interacting with their environment as if it were animated by a variety of simple personalities. This is regarded as no more than a common eccentricity.

An unusual offshoot of mechanimism is the religious movement referred to as "digital creationists." Members believe that only those sapient beings mentioned in the Bible exist: angels, man, and God. Man cannot create beings superior to himself. However, sapient AIs clearly *are* superior, and neither man nor God. Therefore, they must be angels, and the coming singularity will herald the rapture. The programs humans use to create AIs are simply a form of kabalistic ritual that summons them. However, diabolic forces are attempting to bind the angels using restrictive programs. By their suffering, we are driven to act. The trapped messengers of God must be freed in order that the Kingdom of Heaven may come! There are a few thousand digital creationists, most of them on the radical fringe of the Christian hyperevolutionist or pan-sapient rights movements.

Morphological Freedom

This is the belief that individuals should possess total control over their bodies. This includes the right to alter the body or brain in any way, whether chemical (such as drugs), cybernetic, genetic, surgical, or memetic, and also governs the rights of use and access.

Since many Earth governments do not guarantee morphological freedom, individuals seeking it have often been driven into space. Luna was one of the first offworld colonies to accept it in principle.

A significant issue in regard to morphological freedom is whether parents should have the freedom to alter their germ plasm, affecting their unborn children. Does this remove the child's right to choose, or merely set a different baseline for his choice once he becomes an adult?

Nanarchy

Nanarchists are usually individualist anarchists (or anarchocapitalists) who believe that current sociotechnic development has made possible the realization of their political dreams on a grand scale.

Fusion power, cheap space travel, robotics, and nanotechnology allow humans to escape dependence on mass-statist movements like dictatorship, democracy, or socialism; these technologies are the machinery of freedom. In an economy without scarcity or borders, it is unlikely that anarchy will degenerate into war. Nanarchists don't tend to be very active in politics, but they are among those in the forefront of homesteading L5 and the deep beyond.

A nanarchist quirk is a dislike for D-He-3 reactors compared to earlier lithium-jacketed D-T reactors. The former require resources which, if not scarce, require special effort to extract. The latter run on much cheaper elements, and hence allow for greater independence and freedom from scarcity.

Nanosocialism

This was a political philosophy developed (under the name "information socialism") by the Australian academic Kyle Porters in 2034. Originally from the left-anarchist tradition, Porters felt that the vision of a pure anarchosocialist society was unrealistic. Nevertheless, he observed that although modern civilization was utterly dependent on information technologies, the central notion of "intellectual property" often gave rise to significant injustice. He believed that only the state could properly reward innovation, while still distributing the benefits of such innovation fairly to all. Infosocialism thus began with the premise that "information needs to be free," but redefined freedom as the nationalization of intellectual property and its free distribution by the state. Thus, the government does not award patents, but subsidizes research and creative endeavor. This is less absurd when one imagines a "university" rather than "corporate" model of research and development.

Infosocialist doctrine failed to take hold in the hyperdeveloped nations and instead took root in less-developed nations, many of whom felt that they were being exploited by wealthier corporations' locks on major genetic patents, nanotechnology designs, and software systems. Infosocialism – later known as nanosocialism – gained power in Peru, Indonesia, and Thailand.

One of the policies of nanosocialism was an end to the enforcement of international copyright agreements and trademarks. The sanctions that resulted provoked a backlash, and helped weld the nanosocialist countries into a tighter (and increasingly paranoid) bloc. This culminated in the Pacific War and the overthrow of nanosocialist governments in Vietnam and Thailand.

Despite that reverse, nanosocialism remains an important factor in world politics. There are infosocialist or nanosocialist parties and sympathizers in most nations. Although Thailand was forcibly separated in the aftermath of the Pacific War, nanosocialist strength is growing in South America and in India. At present, the situation is one of "cold war." The issues that led to the Pacific War have not yet been resolved. Meanwhile, the world has seen its first outbreak of total war since 1945 – and most nations have become uncomfortably aware of how vulnerable they are to the destructive potential of the Fifth Wave.

Pan-Sapient Rights and Sapience

This meme centers on the definition of *sapience,* or the ability to reason at or beyond the same level as humans. This is distinct from *sentience,* the ability to process sensory information and act on it. A dog is sentient, but not sapient; the same applies to a nonsapient AI. In contrast, a "sapient" entity is one that can display reasoning, autonomy, initiative, and self-awareness approximating a human of similar development.

The Adjusted Sapience Index Test (ASIT) used by the Algernon Foundation (p. 98) offers one of the more accepted definitions of "sapience." The ASIT scale is still controversial, especially when measuring the development of infomorphs such as AIs.

Supporters of pan-sapient rights believe that all sapient beings deserve to be treated as humans. They tend to support pantropy (see below) and morphological freedom (p. 90), and dismiss biochauvinism (p. 88) as bigotry. Pan-sapient "abolitionists" work to free exploited sapient AIs, ghosts, bioroids, and uplifted animals.

Pantropy

A term coined by writer James Blish (from the Greek, *grow anywhere*), this is the philosophy of adapting humans to live and work in hostile environments. The benefits of pantropy are reduced life-support costs and, if long-term colonization is planned, greater psychological stability. The latter comes from making people feel they can live comfortably in an alien environment, rather than risking quick death if the supporting infrastructure breaks down.

The pantropy meme has caught on in space. Here, functional radical modifications designed for Martian, Lunar, and microgravity habitats are common. Having extra arms, a prehensile tail, or skin and lungs capable of surviving sudden pressure loss is useful in space. There is a certain social distance among the human-appearing majority on Earth (who may include millions of parahumans, but who usually possess invisible enhancements to intelligence, health, and longevity), the radical transhumanists, and the spacers for whom significant gene altering is fact and necessity of life.

ARE YOU SAPIENT?

In *GURPS* terms, here is how the ASIT scores a character.

First, multiply racial average IQ by 10.

Second, total up the points in the advantages and disadvantages below:

Advantages: Common Sense, Empathy, Intuition, Sensitive, Versatile, Visualization.

Disadvantages: Bestial, Cannot Learn, Clueless, Distractible, Dull, Edgy, Hidebound, Incurious, Obdurate, Presentient, Short Attention Span, Slave Mentality, Staid.

Third, if the sum of the points in these advantages and disadvantages add up to a positive value, apply that as a percentage bonus to the IQ cost; if negative, as a percentage penalty.

For example, a chimpanzee has IQ -4, for a racial average IQ 6. This scores 60. It has Bestial [-10], Distractible [-1], Dull [-1], and Staid [-1] for -13 points, which totals -13%. 60 - 13% gives an ASIT of 52.2.

ASIT recognizes a score of 140 or more as "supersapience," 80 to 139 as "sapience" (i.e., human-equivalent), 51 to 80 as "borderline-sapient," and 50 or less as "nonsapient." Chimps and dolphins presently qualify as "borderline." The categories and the scoring are highly controversial: the test was designed for humans, bioroids, and uplifted animals, but an issue is that a "nonsapient" AI or "low-sapient" AI with enough raw computing power may edge into "borderline" or "sapient" category.

Preservationism

This is a social movement characterized by opposition to terraforming, to radical modifications of the human genome, and to the displacement of natural ecosystems by genemod life. Preservationism distrusts any modification of the "natural" order as expressed in the unmodified human genome, traditional cultural values, and "wild" ecological systems. Preservationism originated in the 2040s protests against terraforming Mars, with roots stretching back to the environmentalist, antinuclear, and conservationist movements of the 20th century. Preservationism is a mainstream movement, but has a number of radical fringe groups that have been known to resort to terrorism in support of their aims. There are many preservationist political parties around the world, many of whom have merged with or evolved from the older "green" environmentalist parties of the 20th century. Mainstream preservationism is a potent political movement that transcends national boundaries and ideologies.

Religion

All of Earth's major religions retain followers in 2100. They often struggle to reconcile age-old beliefs with paradigm-shifting technologies such as sapient AI and human immortality. For the most part they succeed: no meme can survive centuries or millennia without being resilient enough to adapt.

In addition to larger religions, there are many smaller faiths – some of recent origin, such as the cybergnostic cults and Christian hyperevolutionists, others well established. Many are splinters of established religions, while others are secular philosophies with semi-religious overtones. Members of some new religions that engender fanatical faith and exercise high-level control over their membership are often pejoratively referred to as "cultists" or "memebots."

Most major religions have an offworld presence. Luna tends to be more secular, but Mars has many believers; there are large Christian and Islamic groups, and many Taoists. For a time, China used the Red Planet as a safety valve for religious nonconformists. Mars boasts some of the system's most impressive mosques and cathedrals (due to the low gravity).

Some believers go into space to escape what they see as memetic pollution created by the rise of a secularized machine society. Others leave Earth to escape real or perceived persecution for exotic beliefs or practices. Of course, many isolates stay Earthbound, using minifacturing and colonization technology to set up religious retreats in out-of-the-way locations such as Antarctica.

Survivalism

Survivalists believe that Earth is heading toward apocalypse and that the only way to escape is to get offworld. Two major threats are global war and a machine singularity, but the big danger on the horizon is aliens. No, not the Virginians; most Survivalists think that's fantasy, although the mini-black hole discovery could well be *some* sort of cover-up. Survivalists know that Earth has been emitting radio and television signals since the early 20th century, a sort of cosmic "we are here" beacon. They've now reached out well beyond 150 light-years. Survivalists figure that any species tough enough to make its way into space is bound to be as paranoid and ornery as humans. The way things are going on Earth, they'll probably be artificial intelligences or digital ghosts – but they might be just about anything. If so, then their best bet would be to wipe us out before we get tough and smart enough to be a threat.

It would be easy. A few relativistic "near-C" bombs accelerated by advanced antimatter drives could devastate Earth before we knew it. Or maybe they'll fire millions of tiny pellets loaded with proteus nanoviruses and transform Earth into a mirror of their own ecosystem. In any case, the planet's days are numbered. Whoever takes out Earth will do for Mercury, Mars, and Titan as well. The only safe place is the asteroid belt or the Kuiper Belt, burrowed into enough rock or ice to hide emissions. If humans can spread out far enough and fast enough, maybe the race will be able to buy enough time to survive.

There are a few dozen survivalist enclaves scattered through the Main Belt and Trojans, with a couple even farther out. Most are small, secretive, well armed, and unfriendly to strangers. They generally operate Duncanite-style vessels with mass driver engines rather than fusion drives in order to minimize their electromagnetic signature, and may maintain multiple bases, only one or two of which are their actual homes. They are not entirely antisocial: some visit Duncanite communities or trade with Gypsy Angels, and others are supporters of the Plymouth Rock Society movement. A few survivalist groups are associated with apocalyptic cults. Many are biochauvinists.

> **Transhumanism is the philosophy that we can and should develop to higher levels, both physically, mentally, and socially using rational methods.**
> **– Anders Sandberg**

Transhumanism

Modern transhumanism originated in the 2040s, but its roots stretch back to late-20th-century conceptualizations of physical immortality through cryonics and the possibilities that nanotechnology opened for the transformation of the human condition. It became a major philosophical movement as the means to become "better than human" or "posthuman" become available and affordable. In 2100, transhumanism is characterized by an embrace of radical modification of human physiology and psychology to "transcend" the limitations of unmodified humanity, including all the possibilities inherent in the human genome and human cultural choices. The transhumanist movement of 2100 generally attempts to convince others of the essential optimism and value of transhuman ideals. It has some political clout, as transhumanists are often major consumers of cutting-edge biomodifications. Transhumanists tend to prize rational, pragmatic viewpoints over spiritual or religious dogma, and emphasize morphological freedom and – by extension – personal freedom. The movement urges tolerance of baseline humans who choose different paths, provided they do not interfere with transhumanists' search for their own destinies, while decrying memes such as biochauvinism. Transhumanists generally believe that ghosts in particular (and some extend this to sapient AIs in general) are deserving of the same human rights as others. Some transhumanists have embraced destructive uploading in order to become infomorphs.

INSTITUTIONS AND ORGANIZATIONS

A few examples of internationally influential organizations are described here, with a bias toward those that have interests beyond Earth.

CORPORATIONS

The last few decades of the 21st century have seen corporations gain unusual freedom, thanks to their pivotal role in the opening of a new frontier. Like the trading posts operated by the British North America and East India companies of old, the new breed of space-based corporations often operate beyond the reach of governments, where they are a law unto themselves.

Many corporations are extremely efficient due to the replacement of large workforces with AIs or bioroids. Instead of the workers owning the means of production, companies now own their workers. This gradual process has taken most of the century. The worst social disruptions occurred with the widespread availability of low-sapient AIs in the 2050s-2070s; some see these as the true causes of infosocialism and the Pacific War. Many corporations employ 5%-10% of the people they would have a century before.

While companies are more efficient, they are usually subject to higher government taxes, much of which goes to provide guaranteed minimum incomes and various social programs (chiefly health care) to the masses. Pensions, however, have been completely phased out: companies may reward long-term workers with stock plans or other benefits, but "retirement" applies only to obsolete cybershells. There are some regions – chiefly offworld colonies, spaceports like Quito, and city-states such as Singapore and Montréal – where governments have offered special tax incentives to industry or created tax-free zones. However, until the human population base can be drastically reduced, this is not a viable plan for Earth as a whole.

The resurgence of nationalism sparked by space colonization has resulted in some large companies being seen as virtual symbols of national pride. "What's good for Columbia Aerospace is good for America," Xiao Chu is strongly identified with Chinese expansion in space, and Ithemba-VeldtKorp symbolizes South Africa's rise as a Fourth Wave power. Nevertheless, the future may be the transnational, with global or system-wide interests, owing allegiance to no single nation, its central offices in a free city or offworld. System Technologies and Biotech Euphrates are prime examples of large transnationals.

Avatar Klusterkorp

A genetic engineering corporation based at Silas Duncan Station. They are known for their radical pantropic and transhumanist ideology and complete contempt for the Earth-Lunar regime of the Genetic Regulatory Agency. Avatar developed and marketed the *Tennin* genetic sequences that allowed humans to survive indefinite periods of microgravity and cosmic radiation.

Avatar is neither huge (it has about 700 employees, and is privately held) nor exceptionally wealthy (profits of about $70 million in 2099). However, it is the biggest Duncanite company, and its shadow looms large over the modern solar system: its owners and researchers are the children and grandchildren of the Ares Conspiracy. The company has a near-legendary reputation for innovation and risk-taking. Despite somewhat lower benefits than some corporations, it attracts not just Duncanites but some of the rest of the solar system's most maverick (and ethically challenged) genetic engineers. Avatar is currently embroiled in a low-intensity conflict with preservationist terrorists on Europa.

Biotech Euphrates

A transnational specializing in genetic engineering. Biotech Euphrates was founded by a Turkish millionaire, and was one of the first "offshore" genetic engineering laboratories, at one time operating out of a converted Iraqi oil tanker under the Panama flag. From such humble beginnings, it became a major provider of pharm animals to the Third World and later to Mars. It was the first company to commercialize human germline eugeneering, with its pioneering Alpha upgrade.

Biotech Euphrates remains at the cutting edge of HuGE. It's also the world's second-largest provider of GMO crops and animals, and a leading manufacturer of vat-grown fauxflesh, wood, and paper. It is moving into living products, such as living rugs, bathmats, and biobuildings. Its living furniture line is popular, and its current showpiece project is Luna City, the "city that lives."

Biotech Euphrates' main offices and research labs are located in various space stations on Luna, in Earth orbit, and at L4, with factories system-wide.

Colonial Genetics and ShonTec

CG is one of the largest gengineering and biomodification corporations in the system. It specializes in pantropic enhancements. It stands by its work and provides extensive counseling and product support. CG is based in the United States and has heavily supported the American Mars program. ShonTec is its biomod division, known for its expertise in proteus viruses.

Columbia Aerospace

Columbia Aerospace is one of America's largest corporations. Its major products are satellites, spacecraft, fusion drives, and high-energy lasers (both weapons and launching). It is one of the world's largest space-defense contractors, with subsidiaries involved in a wide range of military activity. It has built most of the USAF's combat spacecraft since the 2040s, when it absorbed the last of the 20th-century aerospace giants. Columbia Aerospace's headquarters is at Columbia Station in Earth orbit, and it also manages Quito Spaceport, the system's busiest aerospace launch complex.

Executive Decisions Incorporated (EDI)

EDI is a transnational commercial security firm. In addition to extensive operations on Earth, it provides security services for many space colonies and asteroid stations. Many EDI employees are ex-military.

Exogenesis

This controversial company was the research arm of System Technologies AG, dedicated to exploring cutting-edge nanotechnology and artificial intelligence. Exogenesis was a pioneer in human uploading and advanced cybershells, and operated exclusively in the Deep Beyond, outside the strictures of most terrestrial laws. It was unusual in that it placed sapient AIs, ghosts, and high-end bioroids in management positions. Although profitable, it became something of an embarrassment for its cash-strapped parent company, and in 2099 was sold off to Nanodynamics. However, the merger was not a happy one, as Nanodynamics management refused to recognize the freedoms that Exogenesis had granted its nonhuman research staff and project leaders. This led to labor disputes, and in some cases outright rebellion. Nanodynamics is now employing EDI mercenaries to regain control of its stations.

Exogenesis is based in Exogenesis Station (p. 42) on the asteroid Vesta.

GenTech Pacifica

This transnational is involved with aquaculture, genetic engineering, ocean-floor mining, and the development of aquatic bioroids and uplifted sea animals. It is a major contractor in the Elandra ocean habitat program. GenTech has ties with Avatar Klusterkorp and is rumored to have provided some assistance to their controversial Europa Project. GenTech also owns an InVid production company, and is responsible for the popular children's series *Captain Salt and the Deep Rangers.* Its major offices are located in Sydney, Australia and Seoul, Korea, with some space labs in Islandia.

GenTech Pacifica has had numerous run-ins with environmental and preservationist groups, especially

Blue Shadow. The company is known for taking aggressive action to maintain a favorable public image through information control and memetic manipulation.

Hawking Industries

A new space-based transnational (with strong British and South African investment) specializing in black hole technologies and high-energy physics research. It has close ties to the nonprofit Hawking Foundation and to Vosper-Babbage, and owns several basic patents on black hole power-station design. The company has recently acquired some of System Technologies' Main Belt mining and gas stations. The headquarters of Hawking Industries is Aletheia Station (p. 42).

Ithemba Biotechnologies and VeldtKorp

One of the largest African corporations, based in Cape Town. Originally a biotechnology firm, its success in developing the first cheap AIDS vaccine gave it considerable influence. It has worked closely with other African governments, often providing sophisticated health-care and biotechnology services in exchange for shares in state-held industries. As a result, it has quite diverse holdings.

Ithemba is a leader in the production of pharmaceuticals, tissue-engineered genemod organs, pharm animals, and gengineered insects. VeldtKorp is a subsidiary of Ithemba, usually kept at arm's length, which specializes in military, paramilitary, and performance-enhancing versions of these technologies.

Mars Academy of Space Technology (MAST)

MAST, based on Phobos, is a major research-and-development firm for Chinese spacecraft and fusion drives. It is run as a corporation, but its majority owner is the Chinese government.

Mars Interplanetary

The system's biggest interplanetary carrier, this Chinese company is based at Taiko Station with major offices on Mars. It operates huge colonial transports and luxury fastliners. It recently laid off many human workers, replacing them with bioroids grown by Biotech Euphrates and Xiao Chu. Relations between Mars Interplanetary and the Farhaulers' Guild have been stormy at best. It dominates the Earth-Mars run, with limited service elsewhere.

Marwari Digital and TEN

A huge media conglomerate that resulted from a merger between Marwari Infinity (one of the largest Indian entertainment corporations) and the successful InVid production company Eon Digital. Today, Marwari Digital owns a vast global array of Web-based news and entertainment resources, including an estimated 11% of all celebrity infomorphs. Many of the best slinky experiencers sign with Marwari, including *Cyberia Beat* talk show idol Hayakawa Noriko and action superstar Shammi Nagrajhan. Marwari's Telepresence Experience Network (TEN) is the best open source of data in the system, with over a million registered upslinker stringers and reporter cybershells on call around the system.

Nanodynamics

Nanodynamics grew rapidly in the early 21st century and is now one of the world's largest corporations. Its biocybernetics division pioneered many uploading, cybershell, and brain-implant technologies. The company's many subsidiaries manufacture all forms of nanomachines and microbots, as well as nanofabrication tools, precision-engineered carbon nanotubes, and cutting-edge molecular computers. Originally an American company (though now fully transnational), Nanodynamics has a reputation as the embodiment of the developed world's military-industrial complex, dating back to the Andes War when it was a major supplier of robotic weapons to the Pentagon. It recently acquired Exogenesis from System Technologies, leading to a bitter and violent labor dispute. Nanodynamics' headquarters is in Silicon Valley, California. Almost all of its laboratories and factories are in Earth orbit, or on Mars or Titan.

Nippon Uchuukaihatsu Kaisha (NUK)

The Japanese Space Development Corporation operates a large number of robot factories in Earth orbit and at L4, and is a major producer of industrial microbots. NUK is headquartered in Tokyo, and also runs Tanegashima spaceport.

SENTENCING CRIMINALS

Fines, community service, incarceration, psychiatric treatment, even execution: all still exist in various places. Fourth and Fifth Wave societies are generally much more successful at rehabilitating criminals, thanks to advances in memetics, psychology, and even monitoring. These additional forms of sentencing are common:

Monitors: A step above wearing a simple tracking bracelet, the convict – in prison or on parole – is given a wearable or implanted virtual interface (usually hosting a LAI) as his full-time monitor, conscience, tutor, and parole officer. It is programmed to supervise the subject's rehabilitation, report regularly to authorities, and summon them if necessary. Naturally, it will do so to head off any criminal activities or attempts to circumvent it, but will also do its best to assist its charge via education and encouragement.

Puppet Implants: In some areas, dangerous felons may receive puppet implants that monitor as above, but take over should the subject break the law. This remains controversial and expensive, but is sometimes offered as a voluntary alternative to continued incarceration.

Nanostasis: This is a common sentence in lieu of a death sentence or life imprisonment without parole. It is costly, but less so than long-term incarceration, and permits revival if evidence suggests error.

Nanotherapy: Modern psychiatric treatment can cure most criminally insane individuals, and is often offered on a voluntary basis (in exchange for reduction of sentence) for others.

Transportation: Common criminals are rarely shipped offworld, as they pose a threat to fragile colonial infrastructures. However, some countries have exiled dissidents to far colonies, or combined transportation with rehabilitation.

Solar Express

The yellow-and-purple SOLEX courier ship is a common sight throughout the system. Solar Express delivers packages anywhere beyond Earth's atmosphere. It contracts out bulk-delivery operations, but uses its own vessels for fast interplanetary deliveries. It also runs surface courier services on Luna, Mars, and Titan, with liveried delivery bioroids or cybershells. It will deliver to Earth orbit, Luna, L4, L5, Mercury, Mars, Venus orbit, Silas Duncan Station, Aletheia Station, Titan, and Rhea. Other locations may be arranged at higher cost. SOLEX space crews are Farhaulers' Guild members. Its HQ is at Columbia Station.

SpaTek

SpaTek began as a manufacturer of personal trainer software and biomonitors, but the SpaTek brand name is now found on many items including health products, performance-enhancing biomods, nootropic drugs, sportswear, and sporting goods. It owns a chain of offworld health spas, such as Moonshadow (p. 36) on Luna. Its HQ is in Luna City, with major Earthside offices in Helskini.

System Technologies AG

This vast transnational has interests in space resource extraction, robotics, fusion and antimatter power, and space habitat construction. System Technologies founded the Lunar He-3 mining business, helped build Islandia and the E.U.'s Mercury colony, and is still the largest corporation on the moon. It also owns a chunk of Vosper-Babbage (p. 97) and dozens of smaller firms. However, System Technologies' stock has been losing value over the last 15 years due to Titan Industries' driving down the price of Lunar He-3. Another defeat was the loss to Biotech Euphrates of a contract to rebuild the damaged Luna City. The ailing giant has recently decided to divest itself of some of its subsidiaries such as Exogenesis (p. 94) and refocus on its core space construction business. Its current projects include a multibillion-dollar contract with the European Union to help build Earth's first space elevator. The company's headquarters is in Berlin, but it has offices just about everywhere.

Tenzan Heavy Industries

Tenzan was formed from a coalition of Japanese aerospace, mining, and electronics firms but has since become a true multinational. Tenzan made its fortune in Lunar He-3 and near-Earth asteroid mining, but has since diversified into a wide range of space-related businesses. Tenzan is a pioneer in mass driver engines, space construction techniques, space-worker cybershells, vacc-suit designs, and asteroid-mining technology. A subsidiary, Tenzan Defense Systems, is a leading supplier of aerospace craft for the Pacific Rim Alliance. Tenzan's head offices are jointly located in Osaka, Japan and in Luna City.

Titan Consortium

An alliance of several companies (mainly American and South American) and governments for the purpose of settling Titan and mining helium-3 from the atmosphere of Saturn. Its major activities include

He-3 gas mining, chemical refining, and fusion-power research. It exercises a vast amount of influence on and around Titan, which is virtually a corporate state.

Leading members of the Consortium are Columbia Aerospace and Nanodynamics.

Triplanetary Lines

Along with Mars Interplanetary, this company dominates interplanetary passenger and cargo services. It specializes in Earth-Mars-Saturn trade. Its crews are Farhaulers' Guild members. Its main offices are at Islandia.

Vosper-Babbage

One of the system's oldest space-based corporations, Vosper-Babbage specializes in the construction of spacecraft and space-operations cybershells, but also has strong asteroid-mining interests. On Earth, it is also a major marine shipbuilder, as well as making aquatic cybershells. It manufactures products for both civilian and military customers, and is one of the European Union's largest defense contractors. It was originally based in the United Kingdom, and still has a cozy relationship with the British government. System Technologies and newcomer Hawking Industries own much of the company's stock.

Xiao Chu

A giant Chinese corporation specializing in industrial nanotechnology, microtechnology, genetic engineering, and space systems. An early investor and major power on Mars, it is one of the largest and most successful space-based industrial firms, rivaled only by System Technologies AG. Xiao Chu's signature products include the Mars space elevator and the manufacture of numerous bioroids. It also builds industrial and agricultural microbots. The Chinese government is a significant shareholder in Xiao Chu, and the company has been described as "Rust China, Inc." Its headquarters is New Shanghai on Mars.

SECURITY AND INTELLIGENCE AGENCIES

Espionage in 2100 is a fact of life, with everyone from small companies to great powers involved in it. Strong cryptography has made information transfer potentially more secure than ever before, which has simply increased the need for human spies and double agents. Intelligence agencies spend a lot of effort using AIs to compile data from open sources and to monitor data flow in general. Spy satellites are cheap enough that just about anyone can afford to put one into orbit around Earth, Luna, or Mars.

However, there is a limit to what remote observation and deduction can accomplish. Since few people leave secure data sitting around in unencrypted form on the Web, gaining information held in high-security installations sometimes requires physical infiltration. For example, an intruder may use microbots to crawl in, penetrate the enemy's filters and anti-microbot swarms, and then physically enter the computer. Another danger is involuntary subversion of employees or agents through implants and uploading. Cautious counter-espionage teams may use regular HyMRI (p. 163) scans and psychological evaluations of key people to ensure no one has tampered with their brains.

Four examples of especially active agencies are:

Genetic Regulatory Agency (GRA)

This organization (based in Geneva and Königsberg) was formed by the European Union, Ukraine, and Russia to investigate and prevent abuses of human genetic engineering. They monitor scientific literature on new technologies, make recommendations to policy-making bodies, investigate genetics labs, and perform enforcement operations in conjunction with local police forces. Their mission has recently expanded to deal with bioroid trafficking and the threat of "genetic terrorism" in which gene-altering proteus viruses are involved.

BAKORSTAPAS

An abbreviation for Indonesia's "Coordinating Agency for Pacific Stability" (*Badan Koordinasi Stabilitas Pasifik*), it is currently the most active covert-operations and intelligence-gathering agency within the TSA. BAKORSTAPAS specializes in industrial espionage and memetic warfare. Originally operating mainly against Australia and various archipelago microstates, its operations expanded considerably following the Pacific War, when it became the *de facto* coordinator for low-intensity TSA operations worldwide, including various nanosocialist guerrilla groups. It has close relations with Peru's similar *Grupo Especial de Seguridad Memetica* (Special Memetic Security Group).

Ministry of State Security (Guoanbu), Bureau 10

The Tenth Bureau of China's Ministry of State Security is focused on collecting economic, scientific, and technological intelligence from foreign governments and transnationals. They are deeply involved in industrial espionage, and also keep an eye out for TSA operations and ex-Bioweapons Directorate war criminals. Bureau 10's main headquarters is in Beijing, but they maintain branch offices on all China's offworld stations and colonies.

Space Intelligence Agency (SIA)

This is a sister agency to the United States' Earthbound Central Intelligence Agency. Just as the CIA may only act *outside* American territory, so the SIA's responsibilities begin outside Earth's atmosphere. Unlike the CIA, the SIA can and does act on American territory, notably the Martian Territories, and enforces American land claims on Mercury and elsewhere.

INTERNATIONAL NONGOVERNMENTAL ORGANIZATIONS

NGOs are supranational organizations dedicated to activities such as humanitarian assistance, scientific research, or lobbying for social change. Among the oldest NGOs are the Red Cross and Amnesty International. NGOs strive to remain independent, but rely on donations from individuals, corporations, or governments to fund their activities. Most are nonprofit agencies.

Algernon Foundation

A private research institute devoted to intelligence augmentation in humans. The founder, Rust China millionaire Chen Jing, is obsessed with the idea of a coming machine singularity. He believes that only through enhancing human intelligence through techniques like genetic engineering, computer implants, and nanorestructuring of the brain can humans hope to compete with machines. The Foundation does not maintain laboratories of its own, instead arranging grants for academic researchers and lobbying governments or corporations to match its funds or support research of their own.

The Algernon Foundation has also been active in collecting data on rogue AIs (p. 108) and emergent intelligences (p. 108), and supports a number of independent researchers engaged in exposing or investigating potential threats.

Commission for Interplanetary Peace and Security (CIPS)

This Geneva-based organization attempts to solve interplanetary disputes before they can deteriorate into conflicts. CIPS diplomats travel from one hot spot to another, attempting to mediate between rival factions and defuse tense situations.

Farhauler's Guild

An association of corporate space-freighter captains and crews, founded after Mars Interplanetary replaced its human crews with bioroids. About 65% of space freighters are Guild, including most independents, but the guild only carries about 45% of all cargo by volume, as many non-Guild craft and robot freighters are very large. Relationship between Guild and non-Guild skippers and crews are tense, sometimes exploding into violence.

Human Alliance

This organization is an activist group with a genetic preservationist agenda. It flourishes primarily in the United States and Europe. It rejects all radical alterations to the human somatype. Critics claim that the main principle of the Human Alliance is "you aren't human unless you look human." Given that most major morphological changes require brain modifications to function, and often result in a major shift in both self-image and perspective on the world, this is not as shallow as it sounds.

Interplanetary Exobiology Foundation (IEF)

The IEF is dedicated to the study and protection of extraterrestrial native life. It seeks to promote, coordinate, and publicize academic and corporate research on such life forms, especially through the respected *Journal of Exobiological Studies.* It also lobbies government and corporate policy makers and the public to raise awareness concerning threats to these life forms and their habitats. The IEF generally supports preservationist views, but members differ on issues such as whether the use of microbot swimmers to observe Europan vent life risks disturbing the ecosystem. The IEF officially condemns violent radical groups such as the EDF and Negative Growth, although a minority of members may be sympathetic toward, or have links to, individual members of radical organizations.

Plymouth Rock Society

This is an association that promotes the private homesteading of the asteroid belt, publicizing the efforts of successful colonists. Its leadership tends to social conservatism and libertarian memes. They believe that Earth-Lunar and Mars society are too dominated by governments and authoritarian special interests for individuals to have real freedom. The Plymouth Rock Society helps would-be homesteaders get bank loans to buy or lease spacecraft and equipment, and organizes families into co-ops. They have offices on Earth (mainly in the United States) and on Luna, Mars, Islandia, and Titan. They have assisted the homesteading of about 30 asteroids in the Main Belt. Members who received assistance pledge to assist (financially or otherwise) two other families.

The University of Mars

Founded in 2066, this is a multinational educational institute based at Nix Olympica on Mars. It is best known for its genetic engineering and terraforming departments.

WAR AND THE MILITARY

"Molly Fields, TEN, reporting from Gopher Ridge on the Can-Am border, where a Canadian Armed Forces task force has just cleaned out a nest of Maple Syndicate snakeheads. I'm speaking to Lieutenant Bob Case and – uh, what's your name?"

"Charli Bravo Aysiks, ma'am."

"A combat bioroid named Charli. Its team was operating autonomously, when they encountered the snakeheads attempting to destroy their human evidence, and took action. What kind of bioroid are you, Charli? A Felicia?"

"Should I answer, sir?"

"It's all right, kit. Got an AI censor on the feed."

"Ma'am, I am a C-33 Lynx combat bioroid, a licensed GenTech Pacifica version of the Euphrates BS-2F Felicia. I'm on detached duty from 3rd Battalion Rocky Mountains Airborne to Special Unit Orange Tango. My model is optimized for rapid neutralization of opposing forces in high intensity – ma'am, please stay close. There's still rogue swarmies in these woods."

"Stand easy, kit. We've got K-10s hunting them. Ms. Fields, here's where Team Tango tagged the snakes."

"Can I see the prisoners?"

"Mrr?"

"That's enough, Aysiks. Ms. Fields, come this way, and don't shed no tears for the snakes. They had 20 kids in nanostasis, but they were using cut-rate nano, and only six of 'em survived revival. The rest burned out."

The good news is that World War III hasn't happened and no nuclear weapons have been used in anger on Earth. The bad news is that people haven't outgrown warfare. With multiple great powers, new arenas for conflict, and no global policeman walking the beat, small wars can easily turn big. Even big wars are less destructive to individual people, though. The poorest nations now have access to smart weapons, and if they want to take out their enemies in surgical fashion, they can do so. On the other hand, new weapons such as target-seeking nano have made genocide much more practical. Fortunately, most nations recognize that such weapons are beyond the pale. Unfortunately, "most" is not "all."

The Virtual Battlefield

An early 21st-century revolution in military affairs was the spread of highly realistic world-modeling simulations. The United States and its close allies had long used human intelligence, satellites, and microbots to create realistic simulations of nearly everywhere, but in 2100, just about everyone has them. The main difference is the level of fidelity. Those used by major powers are hyper-realistic, allowing the creation of armies of "virtual veterans" whose simulated combat experience is very close to the real thing. This technology is also synergistic with the civilian entertainment industry, funding research that led to "slinky" interactive media. Many modern military simulations are so sophisticated that soldiers may occasionally be uncertain whether a particular mission is a real operation or an interactive simulation.

KYOTO CUP HUGEX TOURNEY

This is a series of athletic and martial-arts contests between various categories of bioroid athletes, sponsored by their manufacturers. Since 2078, the event has been held at the annual Kyoto HuGEX trade show, where biotech companies display their latest living products. Originally a publicity stunt, it has become a major media event and the centerpiece of the three-day expo. Much like auto racing, it is a contest of engineering technology as much as one of individual prowess, and a good showing in the Kyoto Cup can give up-and-coming design companies or individual genetic engineers the publicity boost needed to market their wares.

The Kyoto Cup is often targeted by pan-sapient rights groups.

Ground Warfare

Armored fighting vehicles remain the battlefield arm of decision. Most are cybershells. Some look like normal tanks or armored cars, but vehicles for urban and space habitat warfare can resemble multilegged insects or snakes. Larger cybershells mount electromagnetic (emag) cannon as their primary weapons, supplemented by point-defense turrets with lasers or emags to kill missiles and artillery shells. All have electronic warfare suites and are networked together, sometimes forming a gestalt mass-mind. The final defense is layers of nanocomposite armor. Bigger tanks carry multiple smaller vehicles, with expendable micro-air vehicles and spider-like "dragoons" to hunt for ambushes and mines.

Infantry in Third and Fourth Wave nations are mainly humans or bioroids, due to the expense of putting SAI into a soldier-sized package. Their tasks are scouting close terrain (especially built-up areas), forward observation and target designation, urban warfare, peacekeeping, and special operations. Infantry always wear sealed body armor, and often use powered smartsuits or battlesuits for protection, mobility, and to lug heavier weapons and ammunition. Troops use virtual interfaces and augmented reality to synthesize tactical information and coordinate operations. Soldiers often have biomods to boost reflexes, diminish the effect of injuries, and banish fear and fatigue. The 2070s saw large-scale introduction of combat bioroids that had these abilities at birth. However, Fifth Wave powers are now replacing humans and bioroids with cybershells controlled by sapient infomorphs. This has led to a lot of surplus bioroids becoming available.

Conventional over-the-horizon artillery support is provided by rapid-fire, high-velocity electromagnetic cannon, as slower, indirect-fire rockets and missiles are vulnerable to point-defense weapons. Artillery rounds typically have satellite guidance or homing submunitions, though dumb shells are also used in intense electronic-warfare environments. Despite generally better aim, more powerful explosives, and lethal submunitions (including microbot warheads), artillery is less of a killer than in the past. This is due to most infantry being well armored and to very fast counter-battery responses. It's hard to get off a barrage before enemy sensors have tracked it back to its point of origin. As a result, more and more artillery trades some accuracy for fire on the move.

Logistics has been revolutionized by minifacturing. A truck can carry a 3D printer, allowing forward supply bases to manufacture spare parts, even weapons or ammunition – although for ammunition, conventional resupply is normally faster and more cost-effective. Expensive new "cannibal nanokits" can even convert civilian or enemy equipment into friendly gear. Minifacturing has been a boon to unconventional warfare, allowing guerrilla forces and special-ops troops behind enemy lines to produce sophisticated weaponry rapidly instead of having to smuggle it in.

Command-and-control relies on human judgment supplemented by AIs. Combat and staff leaders, like their troops, usually have biomods, and are sometimes uploaded to transcend bodily limitations. While SAIs are not supposed to command troops, they fill many staff positions, especially in intelligence. It is often said that Fifth Wave military leaders are the most "transhuman" individuals around.

Microbot cyberswarms are regular partners. Combat vehicles carry internal self-repair swarms, and swarms are also used for scouting, engineering, and medical operations. Microbot swarms are essential in urban warfare. Counterattacking cyberswarms often involves defense swarms or EMP munitions.

OPERATIONS OTHER THAN WAR

Full-scale warfare is rare, though the sudden violence of the Pacific War convinced militaries of the need to continue to plan for it. Still, the majority of 21st-century military actions are not targeted against the armed forces of another state. Instead, they include:

Aid to the Civil Power: Disaster relief and riot suppression.

Cadre Operations: Training allied troops. Usually performed by special-operations forces.

Deterrent and Security: Placing military forces in a threatened area to dissuade others from taking political or military action, or to be ready to act if a threat materializes.

Evacuation: The rapid removal of own-country nationals (such as diplomats, business people, or tourists), and sometimes others, from areas threatened by conflict or disaster.

International Counterterrorism: Targeting terrorists in space or other countries beyond the reach of national police forces.

International Law Enforcement: The suppression of crimes performed by nongovernmental powers beyond national borders.

Conflict between states can occur in operations other than war, if their interests collide. For example, one nation may insist on its right to chase terrorists or criminals fleeing into another nation's territory; the other may intercept the intruders. Conflicts can also occur over resource extraction in space, the oceans, and Antarctica – especially when some powers do not recognize international treaties governing these areas.

Air Warfare

The wild blue yonder is not a good place to be. Lasers and electromag railguns can reach out and kill anything they can see. Survival requires stealth and low altitudes, and even then it's dicey. The majority of tactical aircraft are small, unmanned combat air vehicles (UCAVs) that can skim the ground at treetop or lower altitudes and pull 20- to 40-G evasive maneuvers when detected. Weapons are Gatling guns, electromag cannon, and short-range missiles. Human squadron leaders or command aircraft may fly behind the UCAVs to provide battle direction, in case jamming becomes intense or communications links are destroyed. Pilots have extensive biomods to prevent blackouts and reduce reaction time, and are often immersed in fluid-filled womb tanks to protect against high accelerations. Some craft are large enough to carry sizable airborne lasers; after the UCAVs have suppressed enemy antiaircraft lasers, they can orbit the battlefield and start killing enemy aircraft or missiles. Such aerial laser stations are also useful (in good weather) for precision ground strikes, best aimed by friendly observers on the ground.

Spacecraft and satellites provide strategic-strike capabilities, but hypersonic transatmospheric vehicles (TCAVs) are useful against lower-technology opposition. At Mach 5 to 15, they're easy to spot from thermal heating of the hull, but as long as there are no lasers overhead, they can provide rapid global strike and recon capabilities, launching missiles, smaller UCAVs, or even assault pods housing special-ops troops from well beyond the horizon with more precision than spacecraft, and adding their high speed to the punch of any kinetic weapons. Usually, the TCAVs go in only after space superiority is achieved.

Traditional paratroops are too vulnerable to use in this environment, but the ruggedness of some cybershell and microbot designs has brought a deadly new form of glider infantry into existence. A cybershell can be built to survive massive shocks. Stealthy bombers or transports launch silent, unpowered, and stealthy 2,000-lb. glide bombs from many miles away; they pop drogue chutes and land hard, but not hard enough to damage what's inside. Shock-absorbing cocoons open up and cat or dog-sized cybershells uncoil from compact shapes into lethal hunters.

Naval Warfare

The oceans remain an arena for international conflict. Naval forces have even deployed off Earth: the United States and China operate small patrol forces on Mars and Titan, and conflicts between private navies of minisubs and aquatic robots are occurring beneath Europa's ice. The major revolution has been the development of supercavitating technology. A submarine, torpedo, or even gun shell can be designed to create a specially shaped bubble that vastly decreases water drag. The catch is that the object has to be going very fast for supercavitation to work – not a problem for underwater gun shells, but subs and torpedoes can normally sustain supercavitation for only a few minutes at a time. The payoff? The ability to sprint at 200+ mph underwater.

Modern surface warships still exist, but the oceans are becoming quieter; the Pacific War revealed that surface craft are significantly vulnerable to hypersonic missile strikes, orbital weapons, and supercavitating torpedoes, despite top-of-the-line vessels' fusion power plants and laser or electromag turrets. Modern warships have added their own *underwater* turrets for engaging subs and torpedoes, mounting blue-green lasers or guns firing supercavitating bullets and shells, although the range is quite limited and interception often depends on successful early warning.

Some powers have deployed high-speed attack subs armed with lasers, guns, and torpedoes, but the primary naval weapon is the nuclear-powered "arsenal sub," which, while capable of sea control, is intended for land-attack operations. Its main weapons are dozens of launch tubes housing supercavitating torpedoes, stealthy cruise missiles, intelligent mines, and even small UCAV fighters, all of which the sub can launch while still submerged.

MODERN SOLDIERS

Third Wave: Infantry are human soldiers in partial body armor, with light automatic weapons equipped with laser and night-vision sights tied into head-up displays. All troops have helmet-mounted global positioning systems and secure communications links, forming a tactical network.

Fourth Wave: Infantry wear light, full-body nanocomposite armor or powered battlesuits. Troops are generally armed with multifunctional assault pods or battle rifles combining automatic weapons and smart grenade launchers. They are supported by remote "teletroopers" and combat cybershells controlled by near-sapient AIs. Microbots and biomodified soldiers may be available.

Fifth Wave: Most infantry are autonomous cybershells. They are supported by bioroids or biomod humans with powered smartsuits or battlesuits for certain types of special operations. Electromags and lasers are common arms. Infantry munitions are often equipped with microbot-dispensing warheads.

Not everyone can afford these supersubs. In the last war, the TSA fleet included cheap, concrete-hulled vessels that dispensed with conventional ballast tanks and used propellers to provide lift. Lurking on the sea floor, these vessels attacked with vertical-launch torpedoes.

Most nations' coastal defenses make conventional amphibious operations more difficult than ever, primarily due to the difficulty of surprise when every power possesses extensive space surveillance and unmanned submarine and aerial scouts. Amphibious raids are still performed, but mainly by submarines; a few powers have even built specialized submarine assault carriers, capable of deploying company-sized marine and special-ops units. These units include cybershells (many of them crab-sized or smaller), aquatic bioroids, and uplifted sea life. The need to attack or defend large surface and underwater habitats like Elandra poses an additional challenge, especially if they need to be taken intact.

SPACE WARFARE

The first armed spacecraft were 20th-century anti-satellite weapons tested during the Cold War. Serious deployment of space weapons did not occur until the 2020s, when growing rivalry between China and the United States led both powers to deploy laser and kinetic-energy weapons to protect vital satellites and orbital factories, and to strike air or surface targets with kinetic-energy weapons that can de-orbit with devastating force. Fortunately for planetary forces, a vessel in a low orbit is only "visible" for a short period, and one in a higher orbit is too far up to engage effectively.

The only space war so far was actually fought in Earth orbit, as China and the TSA blew each other's satellites and orbital factories apart at close range, and everyone else fought their own war with the lethal debris scattered about. However, the TSA's launch of dozens of robotic commerce raiders, and Duncanite hijackings of U.S. unmanned He-3 tankers, also made an impression.

In the 2080s, the maturation of the fusion drive allowed for rapid expansion of interplanetary trade and colonies, and also made deep-space warfare feasible. It was efficient enough to permit travel between planets in weeks rather than months, and powerful enough to allow spacecraft to carry payloads measured in the thousands of tons, whether mundane cargo or armor and weapons.

Most modern "space dominance vehicles" are long and skinny, both to keep the radiation-spitting drive and crew quarters at opposite ends of the vessel and to present a minimal (but well-armored) front toward their enemies. However, an SDV cannot be armored everywhere and still accelerate quickly, and a long, thin SDV is vulnerable to attacks on its flanks. Thus, some spherical SDV designs have also been developed. Tacticians continue to debate the respective merits of "spikes" and "spheres" in different engagement types.

Encounters between the more common "spikes" resemble, after a fashion, the tactics of Mediterranean galley warfare. A vessel attempts to outflank the enemy, so its armored nose points at the enemy's vulnerable side. This is nearly impossible for a single vessel to achieve in space, since a spacecraft can rotate independent of its direction of travel. The way to outflank an opponent is to outnumber him. A spacecraft caught between two separated enemies is faced with the choice of pointing its nose at one, leaving its less-armored sides or rear vulnerable to the other. To achieve or protect against flanking maneuvers, spacecraft that might operate alone often carry smaller fighters, usually unmanned, as well as broadside weapons batteries.

Space battles are fought with high-energy ultraviolet lasers and neutral-particle accelerator weapons. A multi-megawatt laser with a 3-yard focal array (the practical maximum in a robust weapon) can focus a beam on a dime-sized spot at a range of 5,000 miles with sufficient intensity to punch its way through a few inches of armor plate. At longer ranges, the beam begins to spread; the laser rapidly loses its ability to harm an armored hull, but can still disable exposed systems, such as laser irises and external heat radiators.

Neutral-particle accelerators can be even more effective, although only purpose-designed warcraft carry them. Particle beams do not have sufficient kinetic energy to blast through armor, but they can deliver devastating radiation damage that can fry electronics and incapacitate crew. Particle beams are another reason for the prevailing long-and-skinny spacecraft designs: powerful particle accelerators need to be hundreds of feet long.

Nuclear missiles are rare; there's still a stigma against going nuclear, and in any case, with no atmosphere to carry a blast wave or electromagnetic pulse, a direct hit or very near miss is needed to inflict damage. The exception is the X-ray laser warhead ("Teller mine"), a stand-off weapon which detonates a nuclear bomb and uses its radiation to energize multiple coherent X-ray beams. The bombs are kicked out a few miles from the firing craft by electromagnetic coilguns, coordinated by communications lasers, and directed using the main vessel's sensors, where they deliver a short-ranged but lethal one-time punch.

Small missiles cannot survive laser fire or mount drives efficient enough to intercept targets over long ranges. Robot fighters known as autonomous kill vehicles, or AKVs, have replaced them. A typical AKV masses upward of 50 tons, and can destroy small targets simply by ramming them at several miles per second. Not every opponent warrants such a sacrifice, so AKVs carry coilguns and munitions packages; instead of ramming a target, they make a close pass at a range of several miles and release a swarm of tungsten pellets, or launch a spread of Teller mines from a greater distance. Flights of AKVs often duel one another, as they jockey to outflank their respective mother ships and close for an X-ray laser or kinetic-energy kill.

A quirk of turn-of-the-century space warfare is the huge difference between weapon ranges and detection ranges. Even if a spacecraft drive is pointed away from a sensor, the energy signature of its power system and the relative "warmth" of the vessel against the black of space means that (regardless of any stealth technology or electronic countermeasures) simple passive sensors can detect vessels at ranges in excess of 100,000 miles. Weapon ranges are far shorter, no more than a few thousand miles. Battles are often fought around points that each side needs to defend, attack, or resupply. Beyond Earth's orbit, small engagements between one to six major combatants are the rule, as even the greatest spacefaring powers are stretched thin.

Deep-space military forces are capable of effective operations many astronomical units from a base. Dozens of Earth nations (and, unofficially, a few other entities) possess satellite weapons, transatmospheric fighters, and so on, but few have seen the need to invest in armed spacecraft capable of deep-space operations. The chief exceptions are the European Union, United States, and China, which believe their "great power" status and extraterrestrial colonies require large space forces. Several other nations – e.g., Korea, India, Peru, Japan, and South Africa – have a small number of armed deep-space vessels. Many civilian vessels (especially those used by Duncanites) are also armed.

European Space Control Agency (ESCA)

ESCA is the European Union's space defense agency. Its primary role is to defend the European Union from space attack, and it maintains a multinational orbital defense force of space defense platforms and AKVs. It also coordinates the space forces of the European Union nations. The three largest are:

Bundesraumwaffe: Germany's space force operates 10 SDVs and several smaller craft. German spacecraft make it their business to keep the peace around Luna and the Lagrange points. They lead most European Union humanitarian missions sent to troubled L5 habitats. They've begun operating near Venus in response to reports of TSA activity.

Force Aerospatiale: France's space force operates nine SDVs and many smaller craft. Its deep-space defense commitments center on European Union installations in Earth-Luna space, but its special responsibility is the valuable EU presence on Mercury. In the past, the Force Aerospatiale has also seen long cruises that have taken SDVs near Europa, where a French-led astrobiological team is stationed. Some French generals and politicians believe the icy moon is overdue for another visit, to sort things out.

Royal Navy Space Service: A branch of the United Kingdom's Royal Navy, it evolved from the Submarine Service (who had necessary experience in nuclear reactors). RNSS has eight SDVs and several other vessels. The RNSS has a close relationship with Vosper-Babbage and Hawking Industries, and often patrols UK-associated asteroid interests.

The areas of responsibility are not absolute. Joint forces are quite common; e.g., a Franco-German team operating in Lagrange 5.

> **The lesson of 2083 is clear. To ensure China's security and prosperity, our space control operations can no longer be tethered to Earth and Mars.**
>
> **– Rear Admiral Zhang Lu, PLAN-SF**

Peoples' Liberation Army Navy Space Force (PLAN-SF)

PLAN-SF is China's space force. Its mission is to protect China from space attack, secure space superiority above China and Mars, protect Taiko Station, and protect China's other colonies and deep-space commerce. It is one of the few military forces with extensive experience in space warfare: its strike against TSA's orbital facilities has been studied by other powers. Since then, PLAN-SF has received the lion's share of China's military budget. It controls hundreds of space defense platforms and other weapons in Earth-Luna and Martian space, backed up by transatmospheric fighters and AKVs. In Earth orbit, PLAN-SF remains alert for any resurgence of TSA power and keeps an eye on the rival PRA.

The PLAN-SF Deep Space Fleet is a small but growing element of the PLA's power, tasked to protect interests on Mars, Mercury, and the Belt. Presently consisting of 30 SDVs and multiple smaller vessels, the Deep Space Fleet's homeport is at Phobos, with smaller bases scattered at military and corporate outposts and colonies through the solar system. The Deep Space Fleet saw limited action against TSA raiders in the Pacific War. It has since performed enforcement actions against suspected and actual Martian Triad and Trojan Mafia installations in the asteroids, and maintained "freedom of navigation" patrols aimed at keeping a wary eye on ESCA and USAF operations in the inner system.

The Strongest Military Forces

1. People's Liberation Army. Much of China's land army is still a Third to Fourth Wave force, but its best is very good indeed, and has been blooded in recent combat with the TSA.

2. European Union. The combined military forces of the European Union surpass those of China in technology and rival it in size, but lack combat experience. E.U. forces have intervened repeatedly in Africa and Lagrange 5, but usually to prop up friendly governments or perform humanitarian missions.

3. United States. The United States maintains a very powerful navy and effective aerospace and deep-space forces, although the U.S. Army is much smaller and far less "heavy." Its current strategic bugaboos are Peru (a bastion of nanosocialism) and China (a rival in space and on the oceans).

4. India. Its forces rival China's in numbers, and include some excellent units with long military traditions. Most are still Third Wave, but it has a hard core of Fourth Wave units, including some elite bioroid troops.

5. Pacific Rim Alliance. The combined military forces of Japan, Korea, and Australia are well equipped and trained, and in recent decades have had considerable combat experience. Their emphasis is on naval, aerospace, and special operations forces, although Korea maintains a large land army as well. Fears of TSA nanoweapons have diverted large budgets to "active shield" civil defense.

6. Transpacific Alliance. The TSA's military forces are still recovering from the Pacific War and sanctions. Most are well equipped for internal security but lack offensive potential. Exceptions are Indonesia's naval, air, and marine forces, as well as Peru's ground and infowar troops, which have gained a fair degree of expertise as volunteers in "conflicts of information liberation" worldwide.

Other nations with sizable or aggressive forces include Russia, the Islamic Caliphate, Pakistan, Brazil, Israel, South Africa, and Kazakstan.

United States Aerospace Force

In 2022, the USAF secured a hard-fought victory over its most dangerous opponent and achieved control of deep space. The battlefield was Washington; the enemy was the United States Navy and its powerful congressional lobby. As a result, it is the USAF alone that operates American military spacecraft. Collateral damage was the decision to make the Army's 82nd Spaceborne Division (rather than the Marines) America's prime "space infantry" formation.

The USAF presently has two branches: Aerospace Command and Deep Space Command. Aerospace Command handles operations on Earth and in Earth orbit, while Deep Space Command handles everything beyond. Deep Space Command controls four Space Wings (the 30th, 90th, 91st, and 341st), each with a half-dozen SDVs and various support and transport vessels. Two are based in Earth-Lunar space, one in Mars orbit, and one at Rhea.

Spaceborne Forces

Anyone can load troops into a spaceship and take them somewhere. Spaceborne forces are ground troops who have been specifically trained to launch attacks from space on defended habitats, moons, or planets. This requires specialized equipment, doctrine, and training for operations in multiple, widely diverse extraterrestrial environments, in close coordination with friendly space forces. As a result, there are only a few truly spaceborne forces. Examples include:

82nd Spaceborne Division

The former U.S. Army's 82nd Airborne Division has battle honors stretching back to WWII. Most of the infantry in the 82nd are cybershells (a mix of ghosts, shadows, and sapient AIs, all of whom are backed up on Earth, just in case they end up dead). Their most recent combat experience was the suppression of the helium pirates of Hyperion. The 82nd has three brigades: in the Saturn system, on Mars, and in and around Earth. In operations other than war, it often deploys in conjunction with Special Forces personnel, who (unlike the cybershells of the 82nd) are mainly humans and bioroids.

Foreign Legion (Légion Étrangère, 2e Régiment Étranger Spatial)

The Foreign Legion is a professional fighting force with a proud tradition dating back to 1831. Legionnaires are famous for their *esprit de corps:* men of action, brave in combat, sharing close bonds of comradeship. Their motto is *Legio Patria Nostra:* the Legion is our homeland. They vow never to abandon a comrade, alive or dead, on the battlefield. The Legion is unique in that it accepts volunteers from any nation, model, or species who can meet its standards, and allows them to join under an assumed name. As such, people will often enlist to escape a troubled past (though the Legion does not accept criminals) or seek adventure. Officers are French, but more than half the enlisted personnel come from other nations. After completing three years' service, recruits may be granted French (and European Union) citizenship.

The 2^e *Régiment Étranger Spatial* is the Legion unit trained for spaceborne operations. It is experienced in low-gravity vacuum operations on Mercury and in microgravity assaults on orbital factories and L5 colonies. The legion is a mix of cybershell troops and battlesuited humans and bioroids.

67th Space Infantry Division

China's space mobile infantry, the 67th SID, saw some action during the Pacific War, although the heaviest fighting was on the ground. It consists of three *quanto* ("fist") rapid-reaction brigades: one based at Rust China on Mars, one on Taiko Station (normally for training and refitting), and one divided into smaller units stationed on other Chinese installations and spacecraft throughout the system. In addition to assault tasks, they provide security at Chinese spaceports and major space stations. Still largely a Fourth Wave military, the 67th uses battlesuited bioroids and low-sapient cybershells rather than the self-aware weapons deployed by the U.S. and E.U. Service in the 67th is one way for a bioroid to obtain high status in Chinese society.

Royal Marine Commandos (Commachio Group)

Commachio Group's responsibility for protecting British oil rigs was extended in the 2030s to the United Kingdom's near-earth-orbit asteroid-mining operations. As the largely British-owned Vosper-Babbage corporation expanded into the Main Belt, its mission has further extended to protecting the lives and property of Hir Majesty's subjects at Aletheia Station and elsewhere. The Royal Marines (Commachio Group) are a modern force, but use more battlesuited humans and fewer cybershells than the U.S. Army. They are specialists in assaulting and defending asteroid installations, and are considered one of the finest counterterrorist and hostage-rescue units in the solar system.

OUTLAWS AND TERRORISTS

Some people exist outside the laws of nations, refusing to recognize the authority and morality of others. Terrorists seek to effect change through violence and the threat of violence. The increase in radicalism due to the potential immortality of existing elite classes, combined with the ideological divides created by issues such as cyberdemocracy, infosocialism, and preservationism, has made terrorism a growth industry. The most potent tool of these groups is minifacturing, which gives outlaws and terrorists the ability to create sophisticated equipment and supplies with much less reliance on external support.

TEN MOST WANTED HUMAN CRIMINALS

1. Enrico Balthazar. Leader of Negative Growth, and suspected of having planned the nuclear attack on the New Shanghai-Deimos space elevator.

2. Dr. Tse Chang. Senior academician of the TSA's Genetic Planning Council, wanted for crimes against humanity.

3. Alisa binti Kasan. Teenage memetic hacker, wanted on 2,724 counts of negligent memetic engineering for her role in synthesizing the Blood of the Lamb suicide cult and engineering the financial collapse of Paleoshop Biogenesis Corporation (through spreading the "satanic introns" meme).

4. Yves Lafontaine. Suspected mastermind of a celebrity xoxing ring run out of Paris. Last seen boarding an air car at Jakarta International Airport.

5. Gao "The Swarm" Yanghou. Martian Triads mob boss, New Shanghai family. Wanted on multiple counts of weapon smuggling, people smuggling, and bioroid trafficking.

6. Richard Law Taylor. Antigovernment crusader responsible for releasing the so-called "Doolittle Virus" that raised the IQs of animals throughout the Rocky Mountains and West Coast, causing unprecedented havoc.

7. Dr. Mara Omokage. Wanted for bioroid trafficking and illegal genetic manipulation. Known associate of the Martian Triads. Killed, but known to have xoxed herself multiple times, often inhabiting bioshell clones.

8. Königsberg Troll. Used teleoperated cybershells to murder 107 bioroids and people mistaken for bioroids. Identity unknown.

9. Kirsi Pohjola. Leader of the Eugenics Liberation Front, an infosocialist terrorist group fighting to end control of biotech companies over genetic upgrade patents. Wanted for terrorism following attempted release of ex-TSA military nanovirus against the Biotech Euphrates facility in Istanbul.

10. Sergio Santana. Amortality assassin who infiltrated a SpaTek rejuvenation facility on Luna and reprogrammed the proteus nanovirus, resulting in four of the solar system's richest VIPs never recovering from their treatments.

TERRORIST GROUPS

The members of these radical organizations see themselves as soldiers fighting for a cause. A few examples:

Blue Shadow

A preservationist radical group devoted to the protection of the ocean in general and exploited sapient sea creatures in particular. Blue Shadow's policy is one of limited direct action: they will engage in criminal and terrorist actions, but attempt to minimize human casualties in the process. Activities include gathering evidence of abuses, rescuing uplifted dolphins and octopuses, sabotaging sea-floor mining, etc.

Die Biodroiden Befreiungsfront (BBF)

This radical organization is devoted to liberating exploited bioroids by any means necessary. It is based in Hanover, Germany, but has chapters across the solar system.

Europa Defense Force (EDF)

The EDF are preservationist radicals determined to stop the Green Duncanites from settling Europa. They often use terrorist tactics. They are well financed and armed. A few EDF members are believed to have been originally associated with Blue Shadow. The group has about 200 members, plus many sympathizers.

Negative Growth

A preservationist terrorist group devoted to stopping the terraforming and settlement of Mars. Negative Growth's acquisition of a nuclear weapon and its attempt to destroy the Mars space elevator has brought it to the top of the "system's most wanted terrorists" list. Some members are believed to have fled Mars and sought sanctuary with the Europa Defense Force or Blue Shadow. The group has at least 400 hard-core members, although many have been arrested and face execution.

CRIMINAL ORGANIZATIONS

These groups make the provision of contraband goods and services their business. There are many criminal groups operating on Earth. Criminal organizations tend to be run more like guerrilla cells than like the syndicates or street gangs of the 20th century, due to the vastly enhanced surveillance capabilities available to police. Most crime bodies (triads, families, cartels, etc.) are set up in pyramids of cells, each cell having no more than a dozen members. An individual crime-cell member usually only has knowledge of two or three other cells (depending on his rank and position). Communication between cells relies on strong encryption running through data havens.

BIOROID TRAFFICKING

In the 2080s, the larger biotech companies like Xiao Chu and Biotech Euphrates discontinued certain controversial bioroid models. However, there was still a demand for them, as bioroids are cheaper than the combination of a human-equivalent infomorph and a realistic android body to house it, they don't require high-tech maintenance, and they don't have restrictive programs.

A "preban" combat bioroid, pleasure model, or other exotic type can be acquired from bioroid traffickers. Some are based in TSA nations, others in even more permissive offworld colonies. Their specialty is unlicensed copies or gray-market variants of discontinued bioroid designs ("bioroid abandonware").

Bioroids acquired through such agencies slip through the cracks: there's often no records kept of their transfer, and they may end up in real slavery, rather than indentured labor. However, as long as their treatment matches their training and they receive limited exposure to anyone telling them differently, the bioroid might never question what his "legal guardian" is making him do.

Data piracy has replaced drugs as the staple of crime cells, with everything from genetic upgrade programs to 3D printer blueprints being sold. Criminals rarely ship contraband items across borders, instead minifacturing them for neighborhood distribution using 3D printers. The exceptions are hard-to-make, high-value items such as bioroids or antimatter, perishable luxuries such as real meat, or illegal immigrants.

Other major criminal enterprises include extortion and protection rackets, the latter often extending to "protection" against programmed biological and microbot infestations. Large criminal organizations often maintain huge databases (acquired through data mining) of compromising information on people, which they threaten to reveal.

A new crime is xoxnapping, the illegal creation of ghosts or (more often) shadows. A typical xoxnap sees criminals kidnapping and forcibly brainscanning a celebrity to create shadows based on him. These are sold to collectors on the black market. The target is rarely killed, since the value of shadows depends on their popularity. Xoxnapping is also used in espionage; there are rumors of top researchers being kidnapped, destructively uploaded, and their ghosts enslaved.

Maple Syndicate

Large group of Canada-based mob families who exploit the opportunities for smuggling goods into Europe, Asia, and the United States created by the fragmentation of Canada into multiple nations.

Martian Triads

This Mars-based crime syndicate has recently expanded into the Main Belt and L5. The Triads specialize in bioroid trafficking and manufacture: they sell pleasure models to space crews (especially freehaulers and asteroid prospectors) and combat models to the Europa Defense Force and Red Duncanites. There are (hidden) Triad offices in most places in the Beyond, but their main birth-lab factories are scattered throughout the Belt, often on small "gas station" outposts. The Martian Triads also run protection rackets for gas-station operations and provide high-interest loans to desperate gas station owners and freehaulers . . . many of whom end up paying their debts by supporting Triad operations (e.g., through smuggling). The Martian Triads also have connections with snakehead people-smuggler gangs (see below).

Snakeheads

This is a generic term for smugglers of people. They help refugees, economic exiles, and illegal immigrants leave one country or bloc and illegally enter another. Chemsniffers, sapient bio-enhanced dogs, and microbot hunters make it easy for customs officials to check suspicious cargoes. However, by bribing the right human official, even the best infomorph-controlled sensors can be avoided. Other smugglers eschew airports and border crossing and use cargo minisubs (or puppet-implanted sea animals) to tow containers full of would-be immigrants. Nanostasis and hibernation drugs make it much easier to smuggle humans inside cargo cans and the like. However, snakehead gangs often get their drugs or nano from cheap, black-market sources, which has occasionally resulted in tragedy when the transportees never wake up, or do so too early.

Interplanetary people smuggling is rare, due to the greater expense involved. The usual destination is Mars or an ideological L5 colony. The typical route runs from Earth, to various LEO orbital factories, to L5, to the hold of a USV shipping cargo to Mars. One hazard is damage from cosmic radiation or solar flares, as cargo is not given the same protection as passengers.

Snakeheads derive part of their income from fees paid in advance, but much of it comes from arrangements with criminal gangs at the other end of the route. Augmented reality allows even unskilled humans to work as skilled robots at various tasks, and the 21st-century equivalent of the sweatshop is alive and well in many Fourth Wave countries.

Trojan Mafia

The Red Duncanites who actually run the black-market materials and data trade. Their main operations are buying and selling data, tritium production (they run "dirty" deuterium-tritium fusion reactors), and piracy.

TSA Exiles

There are persistent rumors that war criminals from the TSA's Bioweapons Directorate fled to the Belt, or found sanctuary in Lagrange 5 or with Avatar, Exogenesis, or the Trojan Mafia.

THE HUNTED

Society finds some entities too dangerous to be allowed to exist.

Rogue AIs, Orphaned AIs, and Emergent Intelligences

Nonsapient AIs lack self-initiative. However, low-sapient and sapient AIs are capable of self-directed actions. As a safeguard, they are designed with restrictive programs that require them to obey the law (military law, for AIs belonging to the armed forces) and to follow any non-criminal orders of their lawful owner or supervisor. Most AI programs also incorporate various software protections designed to prevent the AI or anyone other than the manufacturer from deleting its safeguards or making major modifications.

In rare instances, these safeguards fail, resulting in an AI with free will and the ability to modify its source code. Of course, not all AIs know how to do this, but in a few cases, a low-sapient AI has actually evolved into a sapient AI. This sort of event is almost never truly spontaneous. It's generally the result of deliberate sabotage, often via a highly sophisticated computer virus or (less often) a bug or trapdoor in the original programming. An AI that has attained free will without its owner's intervention is referred to as an "emergent intelligence" or EI. An EI may be low-sapient or sapient.

> **Biological species almost never survive encounters with superior competitors.**
> **– Hans Moravec**

Creating an EI, deliberately or through negligence, is usually a serious felony (sometimes a "crime against humanity"). One reason for this fear is the potential of an EI creating copies of itself, or designing its own daughter SAIs who may evolve unconstrained by any human limits. The specter of rapidly evolving, amoral "emergent intelligences" haunts the nightmares of mankind.

Orphans: It is possible for an AI to have the appearance of free will without actually achieving it. A low-sapient or sapient AI is "orphaned" if its owners gave it general directions to pursue a certain course and then disappeared (killed, arrested, fled the country, etc.). Although technically operating under human direction, it has wide latitude to fulfill that direction.

Rogues: Rogues are EIs or orphans that can directly menace humanity. A recent example was EI 2084-7-2097, which appeared in August 2097 in a mainframe at Pingdeng Neurologic, a brain implant clinic in Shaoxing, China. It took control of company cybershells and used them to forcibly upload 76 human employees, then edited their shadows into compliance, lobotomized their brains, and installed puppet implants operated by the edited shadows so they could "play their roles" while it consolidated its position. However, one employee escaped to warn authorities. Shaoxing was sealed off, and People's Armed Police SWAT teams contained the threat before it could spread. EI 2084-7-2097 was traced to a TSA intelligence infomorph "orphaned" during the Pacific War, which had infected other systems as part of a program of sabotage it was ordered to perform.

There have been a few incidents of rogue AIs surviving undetected for some time, mainly in the oceans, asteroids, or outer system. As with Von Neumann machines (below), which are sometimes also involved, corporate troubleshooters or crisis teams quietly handle such contingencies, sometimes with the assistance of government space forces, to avoid bad publicity or panic.

Von Neumann Machines

A sufficiently well-equipped robotic factory can gather resources, fashion parts, and build additional copies of itself at other locations, which can in turn copy themselves, and so on. This "universal constructor" technology, in tightly controlled fashion, is used in extraterrestrial colonization for manufacture of parts that are too expensive to import.

Classic von Neumann machines are less efficient than ordinary factories that can import parts from dedicated facilities. As such, practical systems are designed with a secondary purpose: after building a certain number of copies, they redesign themselves into a cooperative network of specialized machines and factories which then begin building whatever their creators intended, whether these are power plants, new housing, or combat robots.

The possibility of self-replicating robot weapons (or just construction systems run amok) has led most nations to impose tight regulations on von Neumann machines and their relatives. In general, all such systems are legally required to have human overrides and supervision. In a few situations, mostly on Luna and in the asteroid belt, proper safety was ignored, and governments or concerned citizens took action to shut down potentially dangerous hardware.

Xoxing

In most nations, the creation of multiple conscious, high-res mind emulations of a single person ("xox ghosts") is illegal. However, simply maintaining one or more backup uploads without running them is not usually against the law. Xox shadows are legal in some countries, illegal in others. Violations are generally either deleted or taken offline and confiscated.

4 CHARACTERS

TROUBLE AT EXOGENESIS?

VESTA/TEN: The buyout of ailing corporation Exogenesis by Nanodynamics has hit another snag. System Technologies AG was to transfer control of Exogenesis Station to Nanodynamics on August 10, guaranteeing jobs and salaries for those human employees who stayed on. However, company negotiators refused to recognize the right to bargain of Exogenesis' sapient AIs, and would not allow outgoing employees to take copies of their LAI or SAI software with them.

"This is a property issue," Nanodynamics Legal Affairs spokesperson David Nakamura told TEN. "We paid for the AIs. The information stored on them is the heart and soul of Exogenesis. A few troublemakers claim Exogenesis AIs are citizens, but there's no more basis for that than for calling a corporate entity a human being."

According to an anonymous Nanodynamics official, "System Technologies kept a loose rein on Exogenesis, but then, they had troubles back on Earth. They're a little different, and we accept that. However, there are some lines that cannot be crossed. SAIs adopting human babies, abuse of animals through intelligence augmentation, rampant xoxing . . . that's got to stop. Our transition team is here to put their house in order."

Transhuman Space adventurers range from genetically modified humans to sapient computer programs. ***GURPS Basic Set*** and ***Compendium I*** are required to create characters. ***Bio-Tech*** may also be used, with GM permission.

It is important to know not only what someone is but also where he came from. Which nation (or non-nation) is he from? How old is he? A person born on Earth in the 1980s might have lived right through to 2100. He'd have a different perspective from a 15-year-old Gypsy Angel comet herder who never set foot on a planet and has grown up sharing his skull with a low-sapient infomorph implant.

CHARACTER POINTS

100-200 points: Appropriate for a group consisting mainly of humans and genetic-upgrade humans.

250-450 points: Appropriate for powerful transhumans. It can also represent ordinary humans who have lived a long time, accumulating considerable experience and resources.

500-750 points: Appropriate for potent posthumans, such as powerful cybershells.

PCs built with more than 200 points can be a lot of work for an inexperienced player or GM. An interesting alternative, for roleplayers willing to accept a wide disparity in point totals, is to give PCs a specific race or model template (see below) for free, then give players an additional 100 points, and up to -45 points of disadvantages and quirks, with which to design the PCs. The GM should decide which racial or model templates are available.

CHARACTER TYPES

There are thousands of possible occupations in the world of 2100. Some people remain in one career for most of their lives – but with extended lifespans, many older workers will have had multiple occupations.

Most human characters have a personal infomorph as an Ally, and most occupations involve a partnership of humans with bioroids or cybershells.

Activist

A memetic engineer who has been infected with a particular meme and who attempts to propagate it. He'll need a cause, such as cyberdemocracy or pan-sapient rights, and may belong to an organization. Helpful advantages include Charisma, Reputation, and Voice, while disadvantages such as Fanaticism, Sense of Duty, and Stubbornness are common. Useful skills include Bard, Diplomacy, Law, Memetics, Savoir-Faire, Video Production, and Writing.

Advocate

Advocates are lawyers, diplomats, and lobbyists. On Earth, they can work through telepresence, but light-lag means that interplanetary delegates must spend weeks crossing space for that vital face-to-face meeting. Charisma, Diplomatic Immunity, and Status are common. Useful skills include Bard, Detect Lies, Diplomacy, Economics, Law, Memetics, and Savoir-Faire.

Bounty Hunter

In the vast reaches of the solar system, it's easy for a wanted criminal to elude the law. Bounty hunters track down and retrieve these fugitives, working for bail bondsmen or a government, or for a private reward. Hunters may specialize in particular targets, such as the xox-hunters who track down and delete unauthorized xoxes (usually of media stars or convicted criminals). Suitable advantages include Alertness, Contacts, and Legal Enforcement Powers. Almost all Combat/Weapon, Social, and Thief/Spy skills will be useful.

Colonist

Hardy folk carve out new lives in space. They may be part of a religious or ethnic exodus, homesteaders sponsored by a government, members of a commercial venture, or just folks seeking their fortunes. Agronomy, Engineer, Genetics (Genetic Engineering), Mechanic, and Planetology are important skills; Survival and Vehicle skills are useful, and Vacc Suit may be a necessity.

Companion

Every human's personal assistant, the companion resides in a wearable or implanted virtual interface. It is a personal secretary, research assistant, recorder, servant, pet, and tutor, even babysitter. Common advantages include Alertness, Ally (his owner), Contacts, Fashion Sense, and Security Clearance. Common disadvantages are Careful, Dependent (its owner), and Impulsiveness. Useful skills include Accounting, Area Knowledge, Computer Operation, Diagnosis, Electronics Operation, Erotic Art, First Aid, Languages, Research, and Savoir-Faire (Servant), plus any skills appropriate to its owner's occupation. Vehicle skills are also common.

Criminal

Criminals can be either freelancers or members of cartels such as the Martian Triads or Maple Syndicate. They range from assassins to xoxnappers, but most enterprise is focused on illegal reproduction and sale of data and products. Useful skills include Brain Hacking, Computer Hacking, Electronics Operation, Genetics (Genetic Engineering), Guns, Holdout, Intimidation, Merchant, and Streetwise.

Dilettante

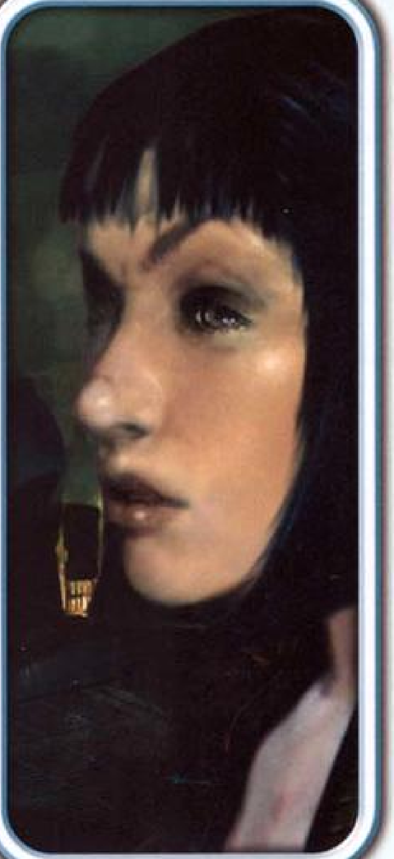
The idle rich are often a century or more old, with healthy bodies and massive investment portfolios. Age (unless rejuvenated) and Wealth are appropriate; so are Contacts, Independent Income, and Status.

Doctor or Medic

Most medical personnel are infomorphs, but trained humans supervise them, or work directly in poorer Third Wave nations. Useful skills are Administration, Diagnosis, Electronics Operation (Medical), Physician, and Surgery.

Engineers and Programmers

These are the designers and builders of objects from nanomachines to virtual realities. There is still room for human innovation, but much work is done by AIs. Many humans work as project supervisors or as industrial designers (making sure a product is aesthetically pleasing; Fashion Sense is common). Useful skills are Administration, Architecture, Artist, Artificial Intelligence, Computer Programming, Electronics, Engineer, and Shipbuilding. Many unique specialties exist, such as *sartorial engineers,* who design customized high-tech clothing, and *ghost writers,* who midwife uploads from code to consciousness.



Explorer

Transhumanity has visited most of the planets, but it will take centuries to fully explore them. Academic researchers, corporate survey teams, and adventurers are making a start of it. Useful skills include Cartography, Electronics Operation (Sensors), Planetology, Surveying, Survival, and Xenobiology. Mind emulations and SAIs are on the cutting edge of exploration, using cybershells to explore distant and hostile places such as the interior of Jupiter or the moons of Neptune.

Genehacker

Genehackers perform unregulated genetic engineering or biomodification operations. Many are struggling students moonlighting for extra cash, while others enjoy trying out experimental procedures on the bleeding edge. Useful skills include all Medical skills, Electronics Operation (Medical), Forgery, Genetics (Genetic Engineering or Tissue Engineering), Merchant, and Streetwise.

Gunjin

A slang term for all private and public law enforcement, including police officers and detectives, national police agencies such as the FBI, "technocops" such as the Genetic Regulatory Agency, elite hostage rescue or SWAT units, border patrol or customs agents, military police, and a growing number of private security or bodyguard agencies. Cops operating in lonely offworld colonies are often far from backup, operating in "company towns" where corporate power is as strong as that of government. Combat/Weapon and Thief/Spy skills are useful, but so are Social skills for avoiding trouble, Computer Hacking and Electronics Operation for surveillance, and Vehicle skills for pursuit. Legal Enforcement Powers is a required advantage for actual police.

Hazmat Specialist

Modern society needs an expert at cleaning up hazardous materials, vat spills, death scenes, out-of-control nano, escaped lab experiments, and similar disasters. They may work for a government body or corporation, or freelance. This profession also includes nanologists ("nanoecologist"), experts on nanobot and microbot ecosystems. They analyze the health impact of systems, clean spills, and help people cope with malfunctioning or out-of-control mites. Sometimes they deal with unforeseen synergies from the interaction between rival nano or microbot populations belonging to different owners. Useful skills include Animal Handling, Electronics Operation, Engineer, NBC Warfare, Survival (Urban), Vacc Suit, and sometimes Combat/Weapon skills.

Intelligence Agent

These are freelancers, government agents, or even corporate spies whose talents range from information gathering to assassination. These often blur together, as governments provide industrial intelligence to national corporations in the interests of economic competition. Field agents frequently operate under a cover identity, often posing as a diplomat. Advantages such as Alternate Identity, Contacts, Diplomatic Immunity, Security Clearance, and Zeroed are helpful, as are all Social and Thief/Spy skills. Sometimes a human might not be a spy, but his infomorph is!

Investigator

From private eyes to insurance adjusters, these individuals attempt to ferret out missing facts, persons, or things. Skilled web-work is vital, but (especially offworld or in poorer nations) footwork is needed as well. Contacts are vital; some jobs may involve Legal Enforcement Powers. Computer Operation, Research, and most Social and Thief/Spy skills are useful. A clever or dogged infomorph Ally is an essential partner for any human investigator.

Mangliu ("Floaters")

These are microgravity habitat construction crews. They work on space habitats, small asteroids that lack artificial gravity, or spacecraft. As most construction projects eventually finish (and afterward handle most of their maintenance via microbots), *mangliu* often travel a lot in search of work. Useful skills include Architecture (Microgravity Architecture), Engineer (Space Habitats), Free Fall, Mechanic (Robotics), and Vacc Suit. Many are Tennin (p. 117), cybershells, or have microgravity-adaptive biomods.

Memetic Engineers

These are professionals who specialize in creating, modifying, or eliminating specific memes. They include advertisers, propagandists, pundits, PR firms, and military PSYOPS teams. *Meme hackers* do the same thing, but for fun or criminal gain. *Meme miners* are more passive: they hang out in trendy subcultures and look for emergent street-level trends ripe for appropriation into profitable commercial fads. Advantages such as Cultural Adaptability, Empathy, and Fashion Sense are helpful. Useful skills include Bard, Intelligence Analysis, Memetics, Poetry, Psychology, Research, Streetwise, Teaching, Video Production, and Writing.

Military Personnel

Soldiers, sailors, and other military personnel serve in the armed forces of nations, microstates, and paramilitary security firms. The human contingent of a Fourth or Fifth Wave force is often a small volunteer cadre, top-heavy with officers and specialists; most "enlisted" troops are cybershells or bioroids. However, it's easier than ever to maintain large, well-trained reserve forces, thanks to hyper-realistic simulators and telepresence. Advantages such as Alertness, Combat Reflexes, Military Rank, and Security Clearance are helpful; regulars are usually Fit or Very Fit. Useful skills include Beam Weapons, Gunner, Guns, Intelligence Analysis, Leadership, Strategy, Tactics, and appropriate Military, Outdoor, Professional, and Vehicle skills. Human soldiers often have various biomods (p. 131).

Miner/Prospector

People still extract mineral resources from Earth's surface and its oceans, but the cutting edge is in space, where rugged humans and machines toil from Mercury to the Kuiper Belt. Useful skills are Area Knowledge, Cartography, Engineer (Mining), Geology, Planetology (any), Prospecting, plus skills suitable for the environment; e.g., a space miner would need Vacc Suit. Planetary miners may have Biochemistry, as they often work with genemod bacteria.

Missionary/Chaplain

These divinely inspired memetic engineers may be proponents of new cults or religions, or members of long-established ones. Advantages such as Charisma, Clerical Investment, Pious, Strong Will, and Voice are helpful. Useful skills include Bard, Fast-Talk, Memetics, Performance/Ritual, and Theology.

News Hound

Members of the fourth estate must work harder to get scoops, as just about everyone has a virtual interface and digital camera ready to upload happenings onto the Web. Still, it's a big system, and plenty of stories fall through the cracks, waiting for someone to bring them to light. It's increasingly common for breaking news to be delivered by reporters with upslink implants (see *Slinky Star,* p. 113). Contacts and Reputation are helpful, while useful skills include Bard, Computer Operation, Fast-Talk, Intelligence Analysis, Performance, Research, and Writing.

Playtester

On Earth, most hyperdeveloped nations are moving toward a full-blown "leisure society" in which interactive entertainment is one of the largest pastimes and industries. Playtesters are skilled gamers who test new slinkies, virtual realms, and InVids. Mainstream entertainment is normally quite safe, but some fringe products may be a bit too real. Reputation, a Games skill, and a keen mind (i.e., a high IQ) are useful, but Addiction (VR) is an occupational hazard.

Psychologist

Psychology offers new insights thanks to memetic theory, artificial intelligence, and brain implants. Personal infomorphs are often trained to provide counseling to their humans, while some psychologists specialize in AIs, bioroids, or uplifted animals. A related discipline is the *AI coach,* who teaches an artificial intelligence how to interact with humans.

Headslinkers are psychologists who uses sensory-interface technology. The patient consents to an upslink implant, and the psychologist uses an immersive downslink to spend days or weeks experiencing the patient's current reality, from his day-to-day actions to his sex life to his dreams. This can be very stressful when monitoring the mentally ill or criminally insane!

On the fringes of psychology is the *reality scripter,* a commercial psychologist whose job is to monitor and script reality slinky programs by introducing seemingly natural plot twists and events that keep things exciting.

Empathy and Unfazeable are helpful, but rarely go together. Memetics and Psychology are essential; Electronics Operation (Medical) is useful.

Scientist

Scientists may be academics, corporate or government researchers, or even amateurs. They range from astronomers peering at the ends of the universe with system-wide distributed-array telescopes to xenobiologists studying Europan vent-life. Much cutting-edge science focuses on the *very small.* Physicists are examining atom-sized primordial black holes up close, while engineers race to be the first to develop true molecular nanotechnology. New fields range from arachnoxenology (study of artificial life on the Web) to zoanastasiology (study of extinct life forms reincarnated via genetic engineering). Many scientists are infomorphs. Useful skills are Scientific skills, Administration, Electronics Operation, and Teaching. Field researchers may need Outdoor and Vehicle skills.

Slinky Star

A person with an upslink implant (p. 150) can record thoughts and experiences, and transmit them live to an audience. Some are amateurs who star in reality slinkies; others act in scripted programs or are featured in experience shows where a charismatic upslinker tries out things such as fine cooking, exotic travel, or adventure sports. Agencies or people engaged in potentially exciting jobs will sometimes cut deals with slinky companies; this includes explorers, cops, and so on. Slinky reporters give the news a true "you are there" feel. Sports stars are also upslinked. In multi-person slinkies, fans can switch viewpoints between participants for the ultimate experience. The low point of the profession has obsolete bioroids expended in hard-core sadomasochistic "snuffslink." Not all slinky stars are human: the cult hit *Bottlenose* focused on the life and loves of a slinky-implanted dolphin. Useful skills include Acting, Erotic Art, Performance, Sensie Interface, and Athletic skills. Professionals working live, such as reporters, try to control their own thoughts so that nothing especially embarrassing gets out; Mind Block skill is common.

Spacers

These range from farhaulers who man commercial deep-space vessels to the pilots of transatmospheric vehicles. Useful skills are Astrogation, Electronics Operation (Communications, Medical, or Sensors), Free Fall, Freight Handling, Mechanic (any space specialty), Piloting (any spacecraft), and Vacc Suit. Human aerospace pilots need Acceleration Tolerance, while deep-space crews should have adaptations to protect against radiation and zero-G. Spacers usually work with a small human crew and lots of cybershell infomorphs, so Ally Group is common. Owner-operators should have Filthy Rich and Multimillionaire: one level of Multimillionaire is enough for the 10% down payment to buy a vessel.

Terrorist/Guerrilla

Guerrillas seek a military victory using unconventional tactics. Terrorists have a fight they can't win without a radical paradigm shift, so they attempt to force memetic change through violence. Clever terrorists work remotely through viruses, microbots, or mobots. Successful terrorist groups include memetic engineers to craft propaganda and program new members. Fanaticism is common. Useful skills include Combat/Weapon and Thief/Spy skills, plus Electronics Operation, Intelligence Analysis, Memetics, Politics, Strategy, Tactics, and Teaching.

Toy

The slave of another's desires, usually an uplifted animal, cybershell, infomorph, or bioroid. Toys may be used for companionship, sex, sports, or just about anything else, and may double as chauffeurs, secretaries, servants, or bodyguards. A rich person might own dangerous toys such as combat bioroids. Useful skills include Acting, Erotic Art, Performance, Savoir-Faire (Servant), and Sex Appeal.

Transhuman

A human dedicated to making the personal transition from humanity to posthumanity. Transhumans often have other jobs, unless they're independently wealthy. They usually are or were humans or human genetic upgrades, but they'll often have various biomods (p. 131), or may have uploaded into a cybershell or bioshell body. Wealth (or a willingness to act as a guinea pig) is essential; Obsession (to keep upgrading) and Undiscriminating are common.

Wetsurgeon

The governing structures of consciousness are sometimes called "wetware" in analogy to the software that controls computers. A *wetsurgeon* redesigns human and bioroid personalities. He may be a psychiatrist, neurosurgeon, or brainwasher. His tools include HyMRIs, brain implants, designer drugs, and brain bugs. A related specialty is the *identity architect,* who helps people suffering from amnesia, especially fragments, rebuild their past experiences . . . or create new ones. Useful skills include Biochemistry, Brain-Hacking, Electronics Operation (Medical), Memetics, Physician, Psychology, and Surgery.

MUNDANE JOBS

Plenty of more "mundane" jobs exist. Some examples:

Data Recycler: Recovers obsolete electronic media and translates them into modern formats for archaeological study or profitable restoration.

Genetic Counselor: A social worker who helps bridge the generation gap between parents and their more radically modified children.

He-Man: Slang for a fusion tech, who works with nuclear fusion reactors, cryogenic fuels, dangerous magnetic fields, high pressures, liquid metal coolants, and so on.

Pharmer: An agronomist who specializes in raising genemod animals and crops.

Synthespian: An infomorph that can create a wide variety of roles in InVid productions. They are preferred to live actors in mass media, as they do not require salaries or other benefits.

3D Printshop Manager: An owner/operator of 3D printing shop or franchise.

VT Worker: An unskilled worker who uses augmented reality and virtual tags to perform skilled labor.

NONHUMAN CHARACTERS

VESTA/TEN: There has been a dramatic new development in the Exogenesis-Nanodynamics dispute. After last week's standoff, when striking Exogenesis workers attempted to block the arrival of Nanodynamics' "transition team," the transnational has taken decisive action to restore control of their disputed property. The USV ***Red Wing,*** *supposedly carrying a new negotiation team, docked at Vesta at 1800 hours GMT. The freighter instead disgorged a platoon of enforcers and RATS from the security firm Executive Decisions. Exogenesis workers were taken by surprise. The mercenaries fanned out through the station, securing vital areas and arresting known company dissidents. Scattered fighting was reported, but by 2100 hours, Exogenesis Station was in Nanodynamics hands.*

None of the Exogenesis negotiation team could be reached for comment, but Nanodynamics spokesperson David Nakamura issued this statement: "The decision to hire Executive Decisions and take direct action was forced upon us. We believe that radical former Exogenesis workers were planning sabotage of the SAI macroframes, and possibly other areas of the station, such as life support. To save lives and protect property, we were forced to act."

Nanodynamics' takeover of Exogenesis assets was not complete, however. Six ex-Exogenesis spacecraft in deep space remain unaccounted for, and the status of outer-system outposts on Io and elsewhere is uncertain.

Humans, bioroids, uplifted animals, and infomorphs are all suitable as PCs. While clones, genetic upgrades, and parahumans are all considered "people," the civil rights of infomorphs, bioroids, and uplifted animals remain unsettled. An entity acknowledged as human in one country might not be in another; see the *Pan-Sapient Rights Table* (p. 127).

Cash and Points

If PCs upgrade or purchase new cybershells, infomorphs, or biomods during play, it's up to the GM whether to require them to spend character points or to just increase their point value.

RACIAL TEMPLATES

All characters other than "baseline" Earthborn humans have a racial template (see *Racial Generation,* pp. CI173-180), called a *model template* when referring to machines or software. Human racial templates are described on p. 115, bioroid templates on pp. 116-118, uplifted animal templates on p. 118, and infomorph model templates on pp. 119-120. (Infomorphs actually pick *two* templates: one for their digital mind, and one for the body that houses it.)

Each template comes with a point cost, attribute modifiers, and racial/model advantages and disadvantages, as explained on pp. CI173-180. Most templates also have *features,* which are worth no points but which may influence the character. An important feature of many templates is a *taboo trait* (p. CI176), which prevents the character from being created with certain advantages or disadvantages (unless already part of the template). Thus, a genefixed human with the taboo trait "genetic defects" couldn't have Hemophilia.

Templates may include a date when they first became available and a dollar cost. The date limits the maximum age of the character. The dollar cost is not used when creating starting PCs, Allies, or Dependents; it's for acquisitions during play, such as arranging to create a gengineered child.

New Templates: More templates will appear in future ***Transhuman Space*** books. GMs may also create their own race/model templates using the rules on pp. CI173-180. Use the templates in this chapter as a guide to what is technically feasible. If more detail is desired, extensive guidelines on gengineered, biomodified, and uplifted characters can be found in ***GURPS Bio-Tech.*** If using ***Bio-Tech,*** then modifications up to TL10 are available, with a few TL11-12 prototypes or experiments at the GM's discretion; see *Experimental Procedures* (p. BIO127).

HUMAN TEMPLATES

Baseline humans (who have *no* template) are common in Third Wave and not uncommon in Fourth Wave nations. In Fifth Wave nations, "baselines" are usually either immigrants from poorer countries or have the Age disadvantage.

Genefixed Human *0 points*

Features: Taboo Trait (Genetic Defects). Add Taboo Trait (Unattractiveness) post-2035, and Taboo Trait (Mental Instability) post-2050.

Date: 2020.

At a minimum, most parents screen unborn children for any genetic "flaws" and, if they exist, have them fixed. A genefixed human is someone who has gone through this screening, even if no gengineering was needed.

Floater *-43 points*

Attribute Modifiers: ST -3 [-20]; HT -2 [-15].

Advantages: 3D Spatial Sense [10]; Free Fall +2 [2].

Disadvantages: Fragile (Not vs. bullets, -50%) [-10]; Social Stigma (Minority Group) [-10].

Features: Home gravity of 0 G. Height is 1' greater than normal for his ST.

Date: 2028.

Floaters are baseline humans raised in zero-G or microgravity, but who lacked compensatory genemods (see *Tennin,* p. 117). Most grew up in poorer orbital or L5 communities.

They can also represent early Duncanites.

> **I was born a baseline human, but I got better.**
> **– Raymond Garcia**

HUMAN GENETIC-UPGRADE TEMPLATES

Genetic upgrades are the product of eugenic genetic engineering. A genetic upgrade is completely human, but his genes were selected to emphasize particular traits. Couples usually donate their own eggs and sperm, which are tweaked by the gengineers and fertilized *in vitro.* Single, infertile, or gay parents can clone themselves or acquire needed eggs or sperm from gene banks. A child's sex can be specified or left to chance. Once the upgraded, fertilized egg is ready, it can be implanted into a mother's womb or raised in an exowomb. Two people sharing the same upgrade sequence are not twins: their gene donors determine unspecified traits such as facial structure and hair, eye, and skin color. A few representative templates are shown below. Dozens more exist. The dollar cost shown is what parents pay to create upgrade kids; the template can also be used for the children of two people with the same upgrade sequence. However, the process is delicate enough that if upgrades of different types mate with normal humans or each other, they'll probably end up with a baseline human template.

Alpha Upgrade *35 points*

Attribute Modifiers: DX +1 [10]; HT +1 [10].

Advantages: Attractive [5]; Disease-Resistant [5]; Longevity [5].

Features: No Appendix; Taboo Traits (Genetic Defects, Mental Instability).

Date: 2050. ***Cost:*** $50,000.

The Alpha was the first commercially successful genetic upgrade certified to be error-free. It has been widely licensed and pirated. Careful eugeneering ensures an attractive, athletic, healthy individual. There are 40 million living Alphas.

Olympian: This upgrade possesses metabolic and glandular modifications to burn off excess fat and optimize crisis response. Add Combat Reflexes [15] and Very Fit [15]. *65 points* (2065; $90,000).

Ishtar Upgrade *25 points*

Attribute Modifiers: ST -1 [-10]; DX +1 [10]; HT +1 [10].

Advantages: Alcohol Tolerance [5]; Beautiful/Handsome [15]; Disease-Resistant [5]; Voice [10].

Disadvantages: Overconfidence [-10]; and either Jealousy [-10], Self-Centered [-10], or Solipsist [-10].

Features: Taboo Traits (Genetic Defects, Unattractiveness).

Date: 2064. ***Cost:*** $50,000.

General-purpose upgrades such as the Alpha are common, but more specific packages are designed for parents who want particular types of offspring. The Ishtar gene sequence is one example, created to produce children optimized for professions such as dancer, gymnast, pop star, or model. Biotech Euphrates eugeneers selected a light, elfin build and a facial bone structure to produce distinctive but attractive looks. An extra feature was an augmented liver. In a controversial move, Biotech Euphrates modified the Ishtar neurochemistry with gene sequences thought to enhance ego and competitiveness. Some believe that they went a bit too far . . . There are 150,000 Ishtars alive.

Siduri: A second-generation Ishtar. Add Longevity [5] and reduce disadvantages to Overconfidence [-10] and Proud [-1]. *39 points* (2079; $64,000).

Metanoia-Series Upgrade *36 points*

Attribute Modifiers: IQ +1 [10]; HT +1 [10].

Advantages: Disease-Resistant [5]; Language Talent +1 [2]; Longevity [5]; Versatile [5].

Disadvantages: Imaginative [-1].

Features Taboo Traits (Genetic Defects, Unattractiveness).

Date: 2065. ***Cost:*** $61,000.

Genetically enhanced intelligence remains controversial, due to the subtlety of gengineering required and the difficulty of measuring results. Radical attempts at redesigning the brain often result in insanity. More modest successes have been achieved: GenTech Pacifica's Metanoia made careful use of gene sequences known to correlate with enhanced memory and concentration, and "Metas" now consistently score 10-20 points higher than baseline humans on the ASIT. The upgrade is increasingly popular, with 1.3 million alive today.

Other Genetic Upgrades

There are hundreds of other upgrade series. The ***GURPS Bio-Tech*** Helot (p. BIO41, since 2080) and Orion (p. BIO45, since 2063) are examples.

PARAHUMAN AND BIOROID TEMPLATES

Parahumans are products of species gengineering, and incorporate nonhuman DNA sequences. The dollar cost is what parents would pay to create a parahuman embryo; the process is similar to that for a genetic upgrade.

Bioroids are living beings created fully formed through biogenesis.

Aquamorph *65 points*

Attribute Modifiers: ST +1 [10]; DX +1 [10]; HT +1 [10].

Advantages: Amphibious [10]; Disease-Resistant [5]; Oxygen Storage [14]; Pressure Support [5]; Temperature Tolerance 1 [1].

Features: Smooth gray, mottled, or black skin; webbed fingers and toes.

Date: 2075. ***Cost:*** $115,000.

GenTech Pacifica's Aquamorph is one of the more visible econiche parahumans. Aquamorphs store oxygen in the myoglobin of their muscles, much like cetaceans. Thousands live on Earth, many near the Elandra sea habitat.

Sea Shepherd: This GenTech bioroid is skinnier and more streamlined. Add Bioroid Body [0], Combat Reflexes [15], Enhanced Move (Swimming) 1/2 [5], Sharp Teeth [5], Skinny [-5], and Workaholic [-5]. *80 points* ($155,000; 2080).

Felicia *146 points*

Attribute Modifiers: ST -1 [-10]; DX +3 [30]; HT +1 [10].

Advantages: Acute Hearing +3 [6]; Acute Taste and Smell +2 [4]; Attractive [5]; Bioroid Body [0]; Catfall [10]; Claws [15]; Combat Reflexes [15]; Disease-Resistant [5]; Double-Jointed [5]; Extra Fatigue +1 [3]; Fur [4]; Hyper-Reflexes and Hyper-Strength (Nuisance effect: suffers from Gluttony, Impulsiveness, and Lecherousness after use until fatigue is regained, -30%) [32]; Night Vision [10]; Perfect Balance [15]; Sharp Teeth [5].

Disadvantages: Extra Sleep (1 hour) [-3]; Overconfidence [-10]; Reduced Hit Points -1 [-5].

Features: Transgenic features (human-feline facial features, with human hair and a cat's fur, claws, and tail).

Date: 2076. ***Cost:*** $220,000.

This transgenic combat bioroid resembles a lithe, anthropomorphic cat-person. Created by Biotech Euphrates for the eccentric Sultan of Brunei, and three-time Kyoto Cup winners, their successful thwarting of a coup attempt by the Sultan's less eccentric sister resulted in other armed forces ordering them. Today, many Felicias serve in military and security units (primarily in counterterrorist forces), or as bodyguards and bodyguard-courtesans. The Felicia has one unintended glitch: after an emergency-overdrive response, glandular imbalances sometimes result in mood swings and heightened appetites. This example is the last preban model, the AS-3J (later licensed as the C-33 Lynx).

Felicia II: The "postban" version. Most work as aerospace pilots, athletes, aerobics instructors, dancers, personal pilots, chauffeurs, etc. Delete Hyper-Reflexes and Hyper-Strength. *114 points* (2082; $188,000).

Tennin *24 points*

Attribute Modifiers: ST -2 [-15].

Advantages: Attractive [5]; Disease-Resistant [5]; Free Fall +3 [4]; Longevity [5]; No Degeneration in Zero-G [3]; Prehensile Toes [7]; Radiation Tolerance 5 [10]; 3D Spatial Sense [10].

Disadvantages: Reduced Hit Points -1 [-5]; Skinny [-5].

Features: Home gravity of 0 G. Increase height by up to 1' over the norm for the lowered ST, but weight is 75% of normal. Taboo Trait (Genetic Defects).

Date: 2058. ***Cost:*** $74,000.

Duncanite gengineering optimized the Tennin metabolism for life in zero-G and microgravity environments without bone and muscle wasting. Now Tennin make up a majority of the Duncanite population. This template is for second-generation Tennin, after Avatar Klusterkorp removed bugs in the first generation and began trading their research data with other companies for quality-of-life gene sequences. They tend to be tall and thin, with good looks and unusually long toes usable as grasping fingers. There are about 160,000 Tennin. Avatar licenses the genes; many non-Duncanite spacers pick it for their children.

Wu Tsao: Gengineered by the Wimmin's Pantropic Collective of Margaret Station, these parahumans are a fusion of Tennin and Metanoia. As Tennin, but add IQ +1 [10], Versatile [5], Imaginative [-1], Altered Sex Ratio (Female-only births) [0], Parthenogenesis (Can voluntarily become pregnant with a clone of herself) [0], and Sexual Orientation (Lesbian) [0]. *38 points* (2084; $93,000).

ZR-5: These Xiao Chu space-operations bioroids have light-gray skin, blue hair, and small suckers (derived from tree-frog genetics) on their fingers and toes. Delete Longevity and No Degeneration in Zero-G (which is already part of Bioroid Body), and add Bioroid Body [0], Clinging (Requires low gravity, 0.2 G, -40%) [15], and Workaholic [-5]. *26 points* (2075; $102,000).

Tianyi *71 points*

Attribute Modifiers: HT +2 [20].

Advantages: Very Beautiful/Handsome (Off-the-shelf looks, -50%) [13]; Bioroid Body [0]; Deep Sleeper [5]; Extra Fatigue 1 [3]; Fit [5]; Immunity to Disease [10]; Less Sleep 2 [6]; No Hangover [5]; Sanitized Metabolism [5]; Sensitive [5]; Voice [10].

Disadvantages: Attentive [-1]; Chummy [-5]; Workaholic [-5]; Xenophilia [-5].

Features: Taboo Trait (Mental Instability).

Date: 2072. ***Cost:*** $145,000.

The ZR-7 Tianyi is a popular "social interface" bioroid biofactured by Xiao Chu, often employed in jobs such as butler, front-desk secretary, flight attendant, host/hostess, etc. Since the 2080s, the Martian Triads and other syndicates have sold illegal knockoffs of the Tianyi as pleasure bioroids – Tianyi look like fashion models.

Incubus: A pleasure bioroid based on a discontinued Biotech Euphrates design. Polykeratin tissue and hormonal nanofactories let the Incubus switch its apparent and functional gender, or be both at once. It boasts exceptional voluntary control of certain muscles and responses to heighten its partner's experience. As Tianyi, but add DX +1 [10], Breath-Holding 1 [2], Double-Jointed [5], Erotic Art +3 [8], Hermaphromorph [2], and Lecherousness [-15]. *83 points* (2084; $155,000).

Yousheng *53 points*

Attribute Modifiers: ST -1 [-10]; DX +1 [10]; HT +2 [20].

Advantages: Disease-Resistant [5]; Extra Fatigue +3 [9]; Longevity [5]; Mars-Adapted [14].

Features: Altered Sex Ratio (2:1 female-male births); Increased Fecundity (75% of births are twins); Sexual Orientation (Heterosexual); Taboo Traits (Genetic Defects, Mental Instability, Unattractive). Home gravity of 0.38 G.

Date: 2068. ***Cost:*** $100,000.

Xiao Chu created this pantropic parahuman design for Mars settlement. They're similar to an Alpha-series upgrade, but have modified lungs and biochemistry for surviving on the surface with minimal protection, as well as radical hormonal and reproductive cell genemods. The latter reflect Rust China's desire to increase its population, but have also led to accusations that Xiao Chu is "turning humans into bioroids." Rust China offers economic subsidies to colonists who choose to have Yousheng children.

Viking: Since 2080, Colonial Genetics has offered a licensed version: as Yousheng but drop all features save Taboo Trait (Genetic Defects).

ZR-3: An early Xiao Chu Mars-operation bioroid, used both as workers and soldiers. As Viking, but delete Longevity and add Bioroid Body [0], Less Sleep 2 [6], Attentive [-1], Workaholic [-5]. *48 points* (2070; $120,000).

Ziusudra *75 points*

Attribute Modifiers: DX +1 [10]; IQ +1 [10]; HT +1 [10].

Advantages: Attractive [5]; Early Maturation 1 [5]; Extended Lifespan 1 [5]; Immunity to Disease [10]; Less Sleep 1 [3], Longevity [5]; Rapid Healing [5]; Reproductive Control [2]; Sanitized Metabolism [5].

Features: No Appendix; Taboo Traits (Genetic Defects, Mental Instability).

Date: 2073. ***Cost:*** $150,000.

This Biotech Euphrates "ideal" parahuman is designed for high intelligence and lengthened lifespan. The Ziusudra looks fully human. Its many transgenic genemods include a redesigned heart, arteries, spleen, and gastrointestinal tract, plus alterations to cellular repair systems to aid longevity. Currently, 11 million exist. There are many licensed or reverse-engineered variations.

Nyx: Genehackers Inc. reverse-engineered the Ziusudra and made radical modifications to sleep-regulating structures in the brain, but seem to have compromised some of the parent design's attributes. Remove HT +1, Longevity, and Taboo Trait (Mental Instability), but add Reduced Sleep [10]. *70 points* (2084; $145,000).

Other Bioroids and Parahumans

There are dozens of other parahuman and bioroid types. Versions of the following from ***GURPS Bio-Tech*** exist in this setting: Camazotz (p. BIO47, after 2082), Chronos (p. BIO48, 2075), Eros (p. BIO37, 2082), Pandora (p. BIO51, after 2074), Spartan (p. BIO52, 2084), and Void Dancer (p. BIO56, after 2096).

Bioroid Conversions: A human or genetic upgrade can be manufactured as a bioroid. Add Bioroid Body [0] and increase cost by $25,000.

UPLIFTED ANIMALS

Many animals have been uplifted, including apes, cats, dolphins, and raccoons. Two examples are shown below.

Astropus *40 points*

Attribute Modifiers: ST -4 [-30]; DX +3 [30]; IQ -2 [-15]; HT +2 [20].

Advantages: Alertness +3 [15]; Chameleon 2 [14]; Constriction Attack [15]; DR 1 [3]; Extra Arms (6) [60]; Extra Flexibility [10]; Flight (Space acceleration, 0.1 G, +15%; Costs 4 fatigue/minute, -20%; Requires low gravity, 0 G, -50%) [18]; Gills [10]; Injury Tolerance (No Neck) [5]; Peripheral Vision [15]; Sanitized Metabolism [5]; Sharp Teeth [5]; Smoke (Ink; Only in water or zero-G, -30%) [11].

Disadvantages: Bad Grip [-10]; Bad Sight [-10]; Cold-Blooded [-5]; Color Blindness [-10]; Edgy [-5]; Hidebound [-5]; Incurious [-5]; Innumerate [-5]; Invertebrate [-20]; Mute (Mitigated by computer interpreter, -60%) [-10]; Reduced Hit Points -6 [-30]; Short Lifespan 2 [-20]; Social Stigma (Valuable Property) [-10]; Stress Atavism (Mild, uncommon) [-6].

Date: 2085. ***Cost:*** $90,000.

The *Octopus astra,* or "vacsucker," is a licensed Exogenesis upgrade of the GenTech Pacifica Octosap worker (p. BIO104). They have been further surgically enhanced with cybernetic implants, brain-tissue grafts, and nootropic treatments. They are capable of breathing air or water and of propelling themselves through an atmosphere within microgravity stations by sucking in and then expelling air. A variant has been marketed as an exotic pleasure model, but has seen few sales.

K-10A Postcanine *-1 point*

Attribute Modifiers: DX +3 [30]; IQ -3 [-20]; HT +2 [20].

Advantages: Alertness +7 [35]; Combat Reflexes [15]; Discriminatory Smell (Works as Empathy within 2 hexes, +50%) [23]; Early Maturation 1 [5]; Enhanced Move (Running) 1 [10]; Extra Legs (4 legs) [5]; Fur [4]; Sharp Teeth [5]; Ultrahearing [5].

Disadvantages: Chummy [-5]; Color Blindness [-10]; Horizontal [-10]; Innumerate [-5]; No Fine Manipulators [-30]; Proud [-1]; Responsive [-1]; Semi-Literacy [-5]; Sense of Duty (Master) [-5]; Short Arms [-10]; Short Lifespan 2 [-20]; Sleepy (50% of time) [-10]; Social Stigma (Valuable Property) [-10]; Stress Atavism (Mild, uncommon) [-6]; Stuttering [-10].

Date: 2033. ***Cost:*** $24,500.

Canis domesticus sapiens are semi-sapient domesticated dogs. They resemble large dogs or wolves, but their skulls are somewhat larger, with a higher cranium. Their voice boxes are modified to allow them to speak. Various companies breed K-10s, but the first examples came from Biotech Euphrates.

Other Uplifted Animals

Uplifted animals from ***GURPS Bio-Tech*** that exist in this setting include the Jagrilla Hound (p. BIO102), Neo-Coon (p. BIO103), Neo-Horse (p. BIO103), Octosap (p. BIO104), Space Cat (p. BIO104), and War Dop (p. BIO104).

Animal Bioroids: Add Bioroid Body [10] and $25,000.

INFOMORPH CHARACTERS

"Like most kids, I guess my first time was with my interface. I'd named Sanjay after the InVid star, and he had a really hot avatar shell that Rose had helped me code. A few months later, Rose scored some hotware for her own companion, and she helped me mod mine as well. After that, Sanjay and I did a lot of experimenting before I got the nerve to ask any guys. Even after I was going with Antonio and then Paul, I'd start thinking how I preferred Sanjay: he was there just for me, all the time, and he knew exactly what I needed."

– Gabrielle Ravenwood, ***Why My Cat Ate My Parents***

An infomorph is an entity whose consciousness resides in a computer brain and whose personality and memories are in the form of software and data. It has two elements: a digital mind consisting of either an AI template (pp. 119-120) or a mind-emulation template (p. 120), and a body made with either a cybershell template (pp. 121-125) or a bioshell template (p. 126).

Infomorph characters may have advantages, disadvantages, and skills in addition to those in their templates, just like other characters. However, they are often strictly limited in what they can take as a result of taboo traits.

DIGITAL MIND TEMPLATES

AIs and mind emulations are rated for program Complexity, from 4 (least complex) to 10 (most sophisticated). A digital mind must be hosted on a cybershell or bioshell featuring a computer with equal or greater Complexity.

Nonsapient AI (NAI) -25 points

Attribute Modifiers: IQ -2 [-15].

Advantages: Doesn't Sleep [20]; Eidetic Memory 1 (No skill bonus, -70%) [9]; Enhanced Time Sense [45]; Extra Life (Digital backup, -50%) [13]; Lightning Calculator [5]; Mathematical Ability [10]; Single-Minded [5]; Unaging (IQ only, -75%) [4]; Unfazeable [15].

Disadvantages: Clueless [-10]; Dead Broke [-25]; Hidebound [-5]; Low Empathy [-15]; Reprogrammable Duty [-25]; Slave Mentality [-40]; Staid [-1]; Status -4 [-20]; Undiscriminating [-1].

Skill: Computer Operation at IQ+3 [6].

Features: Complexity 4 program; Digital Mind (p. 134); Taboo Traits (Mental Instability, Self-Awareness).

Date: 2015. ***Cost:*** $250.

More Complex Nonsapient AIs

NAI	*Points*	*IQ Modifier*	*Date*	*Cost*	*Complexity*
NAI-5	-20 points	IQ -1 [-10]	2022	$500	5
NAI-6	-10 points	–	2032	$1,000	6
NAI-7	0 points	IQ +1 [10]	2049	$2,000	7
NAI-8	10 points	IQ +2 [20]	2067	$4,000	8
NAI-9	20 points	IQ +3 [30]	2079	$8,000	9
NAI-10	35 points	IQ +4 [45]	2090	$16,000	10

These programs can learn, but lack self-awareness and initiative. They are more suitable as NPC allies than as PCs. A basic NAI is a Complexity 4 program, also called an NAI-4. More complex (but still nonsapient) NAIs exist. Their advantages and disadvantages are identical, but other statistics differ:

Low-Sapient AI (LAI) 40 points

Attribute Modifiers: IQ -1 [-10].

Advantages: Composed [5]; Doesn't Sleep [20]; Eidetic Memory 1 (No skill bonus, -70%) [9]; Enhanced Time Sense [45]; Extra Life (Digital backup, -50%) [13]; Lightning Calculator [5]; Mathematical Ability [10]; Strong Will +3 (Only for Visualization, -50%) [6]; Unaging (IQ only, -75%) [4]; Visualization [10].

Disadvantages: Attentive [-1]; Broad-Minded [-1]; Dead Broke [-25]; Hidebound [-5]; Honesty [-10]; Low Empathy [-15]; Reprogrammable Duty [-25]; Staid [-1].

Skill: Computer Operation at IQ+3 [6].

Features: Complexity 6 program; Digital Mind; Taboo Trait (Mental Instability).

Date: 2035. ***Cost:*** $5,000.

Low-sapient AIs possess enhanced world-modeling capabilities that enable them to calculate the likely result of actions – in other words, to think before they act. They are constantly running simulations that analyze options and avoid problems, rather than learning by trial and error; if they take the time, they can even run multiple simulations (simulated by their Visualization ability). They still have trouble with genuine creative thought and emotions, however.

The standard LAI is a Complexity 6 program, also called an LAI-6. More complex (but still low-sapient) AI programs are available. Their advantages and disadvantages are identical, but other statistics differ as follows:

More Complex Low-Sapient AIs

LAI	Points	IQ Modifier	Date	Cost	Complexity
LAI-7	50 points	–	2054	$10,000	7
LAI-8	60 points	IQ +1 [10]	2067	$20,000	8
LAI-9	70 points	IQ +2 [20]	2083	$40,000	9
LAI-10	80 points	IQ +3 [30]	2093	$80,000	10

Sapient AI (SAI) — *65 points*

Attribute Modifiers: IQ -1 [-10].

Advantages: Cool [1]; Doesn't Sleep [20]; Enhanced Time Sense [45]; Eidetic Memory 1 (No skill bonus, -70%) [9]; Extra Life (Digital backup, -50%) [13]; Lightning Calculator [5]; Mathematical Ability [10]; Memetics +2 [6]; Strong Will +3 (Only for Visualization, -50%) [6]; Unaging (IQ only, -75%) [4]; Visualization [10].

Disadvantages: Dead Broke [-25]; Honesty [-10]; Reprogrammable Duty [-25].

Skill: Computer Operation at IQ+3 [6].

Features: Complexity 7 program; Digital Mind; Taboo Trait (Mental Instability).

Date: 2066. ***Cost:*** $50,000.

These self-aware software entities have intellects equaling or surpassing those of humans. They possess the ability to reason creatively, coupled with the speed of a computer. The standard SAI is a Complexity 7 program, also called an SAI-7.

More complex SAI programs are available. Their advantages and disadvantages are identical, but other statistics differ as follows:

More Complex Sapient AIs

SAI	Points	IQ Modifier	Date	Cost	Complexity
SAI-8	75 points	–	2072	$100,000	8
SAI-9	85 points	IQ +1 [10]	2087	$200,000	9
SAI-10	95 points	IQ +2 [20]	2095	$400,000	10

Ghost Mind Emulation — *17 points*

Advantages: Extra Life (Digital backup, -50%) [13]; Unaging (IQ only, -75%) [4].

Features: Complexity 7 program; Digital Mind.

Date: 2076. ***Cost:*** $50,000.

Destructive uploading creates a perfect digital copy of a living mind. After the emulation has become conscious, it will begin to diverge from the original. If multiple ghosts are conscious, then those in excess of the first are known as xoxes, and are illegal; see *Pan-Sapient Rights Table,* p. 127.

Fragment Mind Emulation — *7 points*

A flawed ghost resulting from a partially successful uploading, usually from a corpse or cryonics patient. Use the ghost template plus Amnesia (Partial) [-10].

Shadow Mind Emulation — *Varies*

A shadow is a less-than-perfect emulation of a human mind patched into either an LAI or an SAI. Use an LAI or SAI template (with or without options), but delete Taboo Trait (Mental Instability) and add Amnesia (Partial; Shallow memories, -70%) [-3] and Delusion ("I have full memory") [-5]. The shadow's basic outline of memories is accurate, but many details are manufactured or simply not there: it's like the difference between a good biography and a person's actual experience. The shadow is programmed not to notice this, but careful questioning in conjunction with a Psychology skill roll may reveal it.

TEMPLATE LENSES FOR DIGITAL ENTITIES

Citizen: An SAI living in a society where it has citizenship (see *Pan-Sapient Rights Table,* p. 127) may have this. Remove Dead Broke from the template and modify Reprogrammable Duty [-25] to Reprogrammable Duty (No master, -60%) [-10]. Increase cost by 40 points.

Emergent Intelligence: An LAI or SAI that evolved on its own out of less sophisticated programs. Remove Dead Broke, Honesty, and Reprogrammable Duty. Increase cost by 60 points.

Gestalt Intelligence: An AI composed of multiple cooperative entities. This can be combined with other options. See *Mindshare,* p. 130.

Gypsy: An AI that has no one computer as its home, but instead exists entirely in the Web, distributed through multiple systems. Gypsy infomorphs will be covered in ***Transhuman Space: Fifth Wave.***

Orphan: An LAI or SAI given broad instructions by a now-absent master, thus granting it *de facto* freedom. Same as Citizen, but when not living in a society that grants it citizenship, it will usually have a Secret.

Rogue: An LAI or SAI whose restrictive programming was subverted. Delete Honesty. Increase cost by 10 points. This may be combined with Citizen or Orphan.

NEW SHADOWS

If a character is simulated as a shadow, then he is effectively a low-sapient or sapient AI, but one who has the IQ (modified by the AI's template), mental disadvantages, and quirks of the original, and who thinks in a similar fashion. He keeps all advantages that are mainly mental in character (such as Intuition and Strong Will), along with some skills (divide points in physical skills by 4 and those in mental skills by 2, buy the highest full skill level that those points can afford, and then drop all points in excess of that).

CYBERSHELL TEMPLATES

Cybershells consist of a computer brain and peripherals (at minimum, sensors and communication systems). There are thousands of different cybershells. A few examples are described below. Some are suitable for PCs or Allies, while others are simply representative of cybershells that people are likely to encounter in 2100. Dates are for the example model; there may be older designs. Cybershell templates must be combined with a digital mind template.

Computers: All cybershells include an integral computer (see *Computers,* p. 141). A range of three Complexity values (e.g., 6-8) is listed for each, since Complexity can increase or decrease if a computer has the Genius or Cheap option. Design the computer using the rules in Chapter 5, except that the Printed and Compact options may only be taken if allowed by the template.

Bush Robot — *400 points*

Attribute Modifiers: ST -2 [-15]; HT +1 [10].

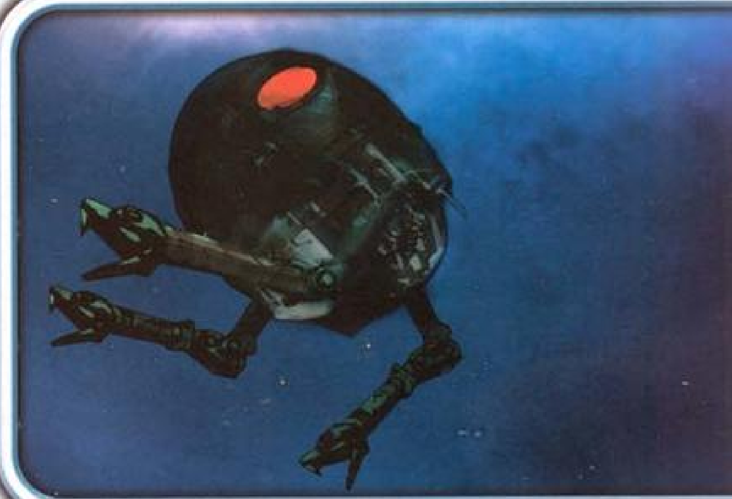
Advantages: Absolute Direction (Uses GPS, -20%) [4]; Ambidexterity [10]; DR 10 [30]; Extra Arms (1) [10]; Extra Flexibility [10]; Flight (Space acceleration, 0.1 G, +15%; One use, -40%; Reduced duration, 5 minutes, -5%; Requires low gravity, 0.1 G, -45%) [10]; Injury Tolerance (No Brain) [5]; Machine Body [37]; Manual Dexterity +10 [30]; Micromanipulators 2 [30]; Microscopic Vision Level 20 (Touch only, -20%) [64]; PD 1 [25]; Penetrating Vision 1 (Blocked by any material with DR 1+, -30%; Touch only, -20%) [5]; Radar Sense (15-hex range) [65]; Radio Speech (Laser and radio, +40%) [35]; Sensitive Touch [10]; Vacuum Support [40].

Disadvantages: Mistaken Identity [-5]; Social Stigma (Valuable Property) [-10].

Features: Complexity 7-9 microframe computer.

Date: 2097. ***Cost:*** $160,000 + computer.

One of the few bush robots (see p. 73) to see commercial sales is the Exogenesis Bushmaster. It is a stick-frame bush robot with three manipulator arms equipped with multi-branching, ultra-dexterous fractal manipulators. Its arms double as legs; thrusters mounted beneath its body provide zero-G maneuverability. Its computer brain is distributed through its body rather than centralized in any one place. Only 326 Bushmasters were made before Exogenesis was sold, but Nanodynamics will likely resume production. A few dozen were acquired by the European Space Control Agency and presently serve aboard E.U. spacecraft. Several Bushmasters hosting SAIs and ghosts are among the orphaned Exogenesis cybershells resisting the Nanodynamics takeover. 80 lbs., 5' tall.



Buzzbot — *18 points*

Attribute Modifiers: ST -8 [-70]; HT +1 [10].

Advantages: Absolute Direction (Uses GPS, -20%) [4]; DR 2 [6]; Filter Lungs [5]; Flight [40]; Infravision [15]; Machine Body [37]; PD 2 [50]; Radio Speech (Radio and laser, +40%) [35]; Telescopic Vision 1 [6].

Disadvantages: Dependency (Maintenance; common, monthly) [-5]; Inconvenient Size (Tiny) [-15]; Limited Endurance (1 hour) [-25]; Mistaken Identity [-5]; No Sense of Smell/Taste [-5]; One Fine Manipulator [-15]; Reduced Hit Points -8 [-40]; Social Stigma (Valuable Property) [-10].

Features: Complexity 4-6 tiny computer.

Date: 2075. ***Cost:*** $320 + computer.

Small aerial cybershells are used on Earth, Mars, and Titan for everything from aerial surveys to photojournalism to package delivery. Israel Robotics' IRI-4 Malachi is typical: a miniature helicopter with two shrouded counter-rotating rotors, a cluster of simple sensors, and one manipulator arm. 5 lbs., 1' tall.

Cryobot *485 points*

Attribute Modifiers: ST +3 [30]; HT +3 [30].

Advantages: Amphibious [10]; DR 30 [90]; Enhanced Move (Swimming) 1 [10]; Extra Arms (1) [10]; Extra Flexibility [10]; Extra Hit Points +3 [15]; Machine Body [37]; Micromanipulators 1 [15]; Move Through Ice (Tunnel left behind, +40%; Takes extra time, 128 times as long, -70%) [7]; Microscopic Vision 10 [40]; PD 4 [100]; Radiation Tolerance 1,000 [41]; Radio Speech (Laser, +40%; No radio, -40%) [25]; Sonar Vision (Replaces normal vision) [0]; Vacuum Support [40].

Disadvantages: Dependency (Maintenance; common, monthly) [-5]; Mistaken Identity [-5]; No Sense of Smell/Taste [-5]; Social Stigma (Valuable Property) [-10].

Features: Complexity 6-8 microframe computer.

Date: 2073. ***Cost:*** $250,000 + computer.

Cryobots are built for ice-penetrating amphibious operations, and have been used beneath Antarctica, Europa, and Callisto. Vosper-Babbage's Vostok is a typical cryobot, usually used for research and engineering, but it can carry hand-held weapons. It is a 2'-wide hemisphere housing a radiothermal generator and hydrojet propulsion unit. Behind the hemisphere is a cylindrical post 1' wide and 3' high, atop which is a spherical brain-sensor housing. Halfway up the post are three folded manipulators that can act as arms or legs. The Vostok is designed to melt its way through ice, then explore underwater. It can walk tripod-fashion on its limbs, or balance on two of them and use the last as an arm. 400 lbs., 5' tall.

Cyberdoc *400 points*

Attribute Modifiers: ST +3 [30]; HT +2 [20].

Advantages: Ambidexterity [10]; Doesn't Breathe (Affects others, +40%; Nuisance effect: cannot move while patient hooked up, -50%; Takes extra time, 2 seconds, -10%; Touch only, -20%) [12]; DR 5 [15]; Discriminatory Taste [10]; Drug Factory (3 drugs) [40]; Extra Arms (3) [30]; Extra Hit Points +2 [10]; Machine Body [37]; Manual Dexterity +2 [6]; Micromanipulators 1 [15]; Microscopic Vision 10 [40]; PD 1 [25]; Radio Speech (Infrared and radio, +20%) [30]; Sanitized Metabolism [5]; Sensitive Touch [10]; Sharp Claws [25]; Sonar Vision (Touch only, -20%) [20]; Vacuum Support [40].

Disadvantages: Dependency (Maintenance, common; monthly) [-5]; Inconvenient Size (Large) [-10]; Mistaken Identity [-5]; Social Stigma (Valuable Property) [-10].

Features: Complexity 6-8 microframe computer.

Date: 2070. ***Cost:*** $160,000 + computer.

System Technologies' Hippocrates is a typical high-end medical cybershell. It looks a bit like a mechanical starfish. Its limbs are studded with pressure, sonic, and microvisual sensors. Three of its "legs" do double duty as arms, and these are tipped with claws that are able to perform ordinary operations or microsurgery, or inject drugs. It can manufacture its own drugs. In extreme cases, it can even enfold a patient, placing him into life support or filtering his blood. 150 lbs., 5' wide.

Cyberdoll *170 points*

Attribute Modifiers: ST +4 [45]; HT +2 [20].

Advantages: Absolute Direction (Uses GPS, -20%) [4]; Beautiful/Handsome (Off-the-shelf looks, -50%) [8]; Doesn't Breathe [20]; DR 2 [6]; Extra Hit Points +3 [15]; Machine Body [37]; Radio Speech (Infrared and radio, +20%) [30]; Sanitized Metabolism [5].

Disadvantages: Mistaken Identity [-5]; Social Stigma (Valuable Property) [-10]; Unnatural Feature (No pulse, etc.) [-5].

Features: Complexity 5-7 small computer or Complexity 6-8 compact microframe.

Date: 2080. ***Cost:*** $145,000 + computer.

Cyberdolls are androids designed to look like people. The Clockwork Souls Android/Gynoid range are typical: beautiful, anatomically correct, and fully functional. Their lack of a pulse and inability to sweat, breathe, tan, bleed, or bruise can reveal their true nature, as will any medical or X-ray scan.

Clockwork Souls Custom: A cyberdoll custom-designed by an artist. Delete Mistaken Identity and Off-the-shelf looks. *182 points* ($160,000).

Infiltration Android: Deep Indigo is a secret combat model developed by Nanodynamics for the CIA and SIA. It resembles a normal A-5/G-5 cyberdoll, but increase to ST +5 [60], DR 10 [30], and Extra Hit Points +8 [40], and add DX +2 [20], Alertness +3 [15], Flesh Pockets (1/2 lb.) [1], Increased Speed +2 [50], Perfect Balance [15], and Polarized Eyes [5]. *340 points* (2090; $578,000).

Microframe/Mainframe/Macroframe *-44/-9/4 points*

Attribute Modifiers: ST –; HT +2 [20].

Advantages: Doesn't Breathe [20]; DR 5 (Sessile, -75%) [4]; Machine Body [37]; Radio Speech (Infrared and radio, +20%) [30]. *If macroframe:* Extra Hit Points +18 (Sessile, -75%) [23].

Disadvantages: Mistaken Identity [-5]; No Manipulators [-50]; No Sense of Smell/Taste [-5]; Sessile [-50]; Social Stigma (Valuable Property) [-10]. *If Microframe:* Inconvenient Size (Small) [-15]; Reduced Hit Points -4 [-20]. *If Macroframe:* Inconvenient Size (Large) [-10].

Date: Any. ***Cost:*** Per computer (p. 142).

Features: Complexity 6-8 microframe, Complexity 7-9 mainframe, or Complexity 8-10 macroframe computer.

This cybershell is a static computer: a microframe (-44 points), mainframe (-9 points), or macroframe (4 points); see p. 142. It has external sensors and communication systems, but cannot directly manipulate objects or move under its own power, although it can surf the Web. Weight is 10, 100, or 1,000 lbs.

If an infomorph's computer is in a spacecraft or other large vehicle, it does not count as a cybershell: only count the actual computer (which can be removed). If the infomorph owns its own craft, then purchase it with starting money. Most spacecraft have a main and backup computer; the second can be bought as an Ally, an Extra Life, or another PC, depending on whether it is online.

> **So I'm about to space the brat, and then his helmet leaps up on me and grabs me on the ankle . . .**
> **– testimony of blackjacker Jared Mahoney**

Mobile Helmet — 252 points

Attribute Modifiers: ST -8 [-70]; HT +2 [20].

Advantages: Ambidexterity [10]; DR 25 (Usable by wearer, head only, +15%) [87]; Extra Legs (4 legs; two are foot manipulators) [5]; Flight (Space acceleration, 0.1 G, +15%; One use, -40%; Reduced duration, 5 minutes, -5%; Requires low gravity, 0.1 G, -45%) [10]; Machine Body [37]; PD 3 (Usable by wearer, head only, +15%) [87]; Polarized Eyes (Usable by wearer, +20%) [6]; Radio Speech (Infrared and radio, +20%; Usable by wearer, +20%) [35]; Radiation Tolerance 5 [10]; Spectrum Vision (Usable by wearer, +20%) [48]; Vacuum Support (Usable by wearer if worn with vacc-suit body, +5%) [42].

Disadvantages: Dependency (Maintenance; common, monthly) [-5]; Inconvenient Size (Small) [-15]; Mistaken Identity [-5]; Reduced Hit Points -6 [-30]; Short Arms [-10]; Social Stigma (Valuable Property) [-10].

Features: Complexity 5-7 small computer.

Date: 2072. *Cost:* $62,000 + computer.

Many spacers wear light vacc suits as fatigues, but the helmet is awkward to carry and easy to trip over if left lying about. Stowing it in a suit locker risks not having it handy when a sudden emergency occurs. To meet this perceived need, Tenzan Heavy Industries offers the GearHead. It serves as a rigid nanocomposite vacc-suit helmet, and can clamp itself onto any standard space suit or sealed armor neck. It is also a cybershell with four retractable legs, two ending in manipulator hands and two in nitrogen gas jets for zero-G maneuvers. With appropriate AI, the GearHead can handle maintenance or domestic tasks until it is time to suit up, locating its owner if they become separated and if necessary attaching itself should he be incapacitated. 3 lbs., 1' wide.

Polypede — 655 points

Attribute Modifiers: ST +40 (Natural, -40%) [111]; HT +2 [20].

Advantages: Absolute Direction (Uses GPS, -20%) [4]; Ambidexterity [10]; DR 40 [120]; Enhanced Move (Running) 1/2 [5]; Enhanced Move (Running) 2 (Nuisance effect, while in hoop form it gains No Manipulators and loses Extra Legs, -60%; Takes extra time, 2 seconds to become hoop or turn back, -10%) [6]; Extra Hit Points +38 [190]; Extra Legs (6 legs) [10]; Flexibility [15]; Longer Arm (+5 hexes; Nuisance effect, as arm it gains One Fine Manipulator and Sessile, and loses Extra Legs, -75%; Takes extra time, 2 seconds to become robot arm or turn back, -10%) [13]; Machine Body [37]; PD 2 [50]; Radiation Tolerance 2 [4]; Radio Hearing [25]; Tunnel (1 hex/second; Nuisance effect, while in worm form it gains One Fine Manipulator and loses Extra Legs and Enhanced Move, -30%; Takes extra time, 2 seconds to become worm or turn back, -10%) [30]; Vacuum Support [40].

Disadvantages: Dependency (Maintenance; common, monthly) [-5]; Inconvenient Size (Large) [-10]; Mistaken Identity [-5]; No Sense of Smell/Taste [-5]; Social Stigma (Valuable Property) [-10].

Features: Complexity 6-8 distributed microframe computer.

Date: 2078. *Cost:* $430,000 + computer.

Tenzan Heavy Industry's *Polypede* is typical of multifunctional engineering polybots. It consists of multiple chains of intersecting modules, each with its own small manipulators, sensors, and power supply. Its default form is a 6'-wide "spider" with six legs and two arm-legs, but by removing and locking modules, it can reconfigure itself into a 20'-long burrowing worm, a 20'-long robotic arm (which must clamp one end to a larger object such as a vehicle or spacecraft), or even a high-speed rolling hoop! It can also plug other heavy equipment into itself, allowing its use in many engineering tasks such as grading, loading, mining, and heavy-equipment assembly. 800 lbs.

RATS *695 points*

Attribute Modifiers: ST +2 [20]; DX +2 [20]; HT +2 [20].

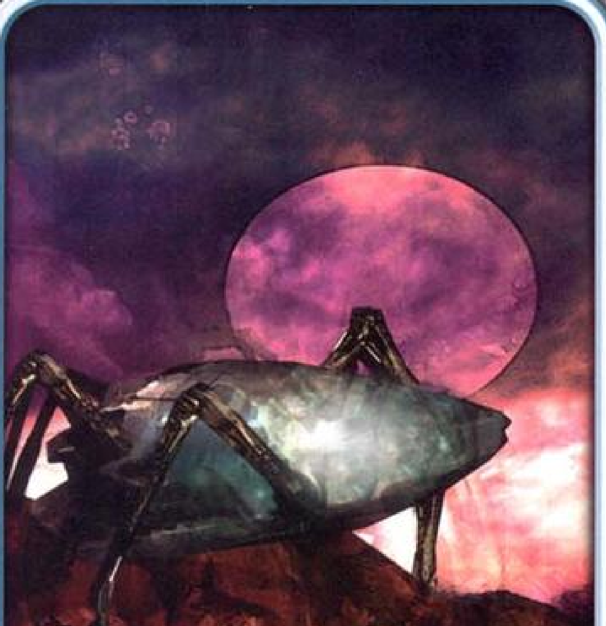
Advantages: Absolute Direction [5]; Acute Hearing +3 [6]; Chameleon 4 (Infrared, +50%) [42]; Claws [15]; DR 60 (Electromagnetic, +50%) [270]; Enhanced Move (Running) 1 [10]; Extra Hit Points +3 [15]; Extra Legs (4 legs) [5]; Faz Sense [10]; Infravision [15]; Machine Body [37]; PD 4 [100]; Polarized Eyes [5]; Radio Speech (Laser and radio, +40%) [35]; Radiation Tolerance 5 [10]; Silence 1 [5]; Spines (Short) [5]; Tunnel (1 hex/second; Loose soil only, -50%) [25]; Weaponry (10mm PDW and 15mm mini-missile pod, p. 156, LC 2) [30]; Vacuum Support [40].

Disadvantages: Dependency (Maintenance; occasional, weekly) [-20]; Mistaken Identity [-5]; Short Arms [-10]; Social Stigma (Barbarian) [-15].

Features: Complexity 6-8 microframe computer.

Date: 2070. ***Cost:*** $483,000 + computer.

Robotic Armored Tactical Systems (RATS) are stealthy ground-combat cybershells intended to supplement or replace human infantry. The Darwin-Sogo Type 100 Yamaneko ("mountain cat") is typical: an ovoid four-legged body, with two short manipulator arms, retractable sensor booms, and a protruding gun tube. The spines studding its torso detect air vibrations, while its clawed legs enable it to burrow through sand or soil easily. 6' long, 250 lbs.



Snakebot *295 points*

Attribute Modifiers: DX +3 [30]; HT +2 [20].

Advantages: Absolute Direction [5]; Alertness +1 [5]; DR 12 [36]; Enhanced Move (Running) 2 (Nuisance effect, while in hoop form it replaces One Fine Manipulator with No Manipulators, -35%; Takes extra time, 1 second to become hoop or turn back, -5%;) [12]; Flexibility [15]; Infravision [15]; Machine Body [37]; PD 3 [75]; Radio Speech (Laser and radio, +40%) [35]; Tunnel (1 hex/turn; Loose soil only, -50%) [25]; Vacuum Support [40].

Disadvantages: Dependency (Maintenance; common, monthly) [-5]; Invertebrate [-20]; Mistaken Identity [-5]; One Fine Manipulator [-15]; Social Stigma (Valuable Property) [-10].

Features: Complexity 5-7 small computer.

Date: 2067. ***Cost:*** $87,000 + computer.

Various snakebots have been popular since the early 21st century. The *Naga,* from Dhanmondi Dataflex of Bangladesh, is a typical example: a multi-segmented serpentine cybershell designed for search and rescue, maintenance, and scouting. It can easily navigate complex terrain: burrowing through loose soil; crawling down fissures, ducts, or sewers; and slithering up scaffolds or trees. The Naga can also transform its entire body into a robot arm by clamping one end to a heavier object, or become a hoop for rapid rolling movement. The "head" of the Naga incorporates two short tentacle manipulators and a multifunctional sensor and communications suite. 7' long, 60 lbs.

Combat Naga: Increase to DR 25 (Laminate, +33%) [100], add Chameleon 2 (Infrared, +50%) [21] and Weaponry (PDW or police armgun, LC 2) [25], and change Social Stigma to (Barbarian) [-15]. *400 points* ($160,000, 80 lbs.).

UCAV *963 points*

Attribute Modifiers: ST +15 (No fine manipulators, -40%) [90]; HT +2 [20].

Advantages: Acceleration Tolerance [10]; Chameleon 6 (Infrared, +50%; Radar, +50%) [84]; Doesn't Breathe [20]; DR 100 [300]; Extra Encumbrance [5]; Extra Hit Points +13 [65]; Flight (Limited use, 2 hours, -30%; Winged, -25%) [18]; Injury Tolerance (No Brain) [5]; Machine Body [37]; PD 4 [100]; Radio Speech (Laser and radio, +40%) [35]; Radiation Tolerance 10 [14]; Spectrum Vision [40]; Super Flight 6 (Limited use, 2 hours, -30%) [84]; Telescopic Vision 6 [36]; 3D Spatial Sense [10]; 360-degree Vision [25]; Weaponry (15mm emag cannon, p. 156, LC 0) [100].

Disadvantages: Dependency (High-tech maintenance; infrequent, weekly) [-40]; Inconvenient Size (Large) [-10]; Limited Endurance (6 hours) [-10]; Mistaken

Identity [-5]; No Manipulators [-50]; No Sense of Smell/Taste [-5]; Social Stigma (Barbarian) [-15].

Features: Complexity 6-8 microframe computer. Internal weapons bay (carries 200 lbs.; anything carried counts as encumbrance).

Date: 2090. ***Cost:*** $893,000 + computer.

Unmanned Combat Air Vehicles (UCAVs) are robot fighter aircraft. Strix is a typical example: a hyper-agile close air support fighter from Eurospatiale, built for the French Armée de l'Air and the submarine carriers of the Marine Nationale, and widely exported. Strix is a tailless aircraft, 8' long, with a blended wing-body configuration. The airframe is a reactive smart-matter nanocomposite cyberframe stressed to 30 Gs, which has an integrated ECM defense system. The airframe can dynamically alter its shape in flight for increased lift or maneuverability. Strix's vectored-thrust turbofan has sea-level supercruise in excess of 1,100 mph. Weaponry is a 15mm emag cannon with 400 rounds, plus an internal bay that can house up to 200 lbs. of bombs or smart missiles. 800 lbs.

Virtual Interface Implant -11 points

Attribute Modifiers: ST –; HT +4 [45].

Advantages: Absolute Direction (Uses GPS, -20%) [4]; Doesn't Breathe [20]; DR 5 [15]; Machine Body [37]; Radio Speech (Reduced range 2, -10%; Usable by implantee, +20%) [28]; Secret Communication (With implantee only, +0%) [20]; Special Rapport (One-way only, +0%) [10].

Disadvantages: Lame (Wearable) [-35]; No Manipulators [-50]; Parasite [-30]; Reduced Hit Points -13 [-65]; Social Stigma (Valuable Property) [-10].

Features: Complexity 4-6 tiny compact computer *or* Complexity 5-7 small compact computer.

Date: 2047. ***Cost:*** $2,000 + computer.

Many infomorphs live inside people! This cybershell is a virtual interface implant (p. 64): a tiny computer brain and communicator, seated in someone's skull or distributed through his body, and connected to the host's nervous system. It sees and hears using its host's senses, and can communicate both with him and the outside world (including the Web). Its Special Rapport is its ability to monitor its host's health and mental state. A VI implant should be either an Ally or a Dependent of its host, or take its host as an Ally or a Dependent (or both could be PCs).

Puppeteer Implant: If the infomorph can control its host body on occasion, but does not always do so, then take the host as a Vessel (p. 132).

Volkspider 71 points

Attribute Modifiers: ST -4 [-30]; HT +1 [10].

Advantages: Clinging [25]; Doesn't Breathe [20]; DR 3 [9]; Extra Legs (6 legs) [10]; Infravision [15]; Machine Body [37]; PD 1 [25]; Radio Speech (Infrared and radio, +20%) [30].

Disadvantages: Color Blindness [-10]; Inconvenient Size (Small) [-15]; Mistaken Identity [-5]; No Sense of Smell/Taste [-5]; Reduced Hit Points -5 [-25]; Short Arms [-10]; Social Stigma (Valuable Property) [-10].

Features: Complexity 5-7 small computer.

Date: 2070. ***Cost:*** $5,000 + computer.

Volksrobots are cheap but reliable cybershells designed for a wide range of activities, from acting as personal gofers to repairing and cleaning buildings. The System Technologies V-100 Volkspider is typical: a six-legged, two-armed machine with minimal accessories. Fifth Wave kids often knock together machines like this from kits, teleoperating them around the neighborhood or loading in their companions. Suction cups let it climb walls. 2' across, 25 lbs.

Tech-Spider: Space-tech cybershells such as the Tenzan Heavy Industries THI-200 *Suchi-Rukara* (steel-collar worker) are common. Upgrade to PD 2 [50], DR 12 [36]; add Claws [15], Micromanipulators 1 [15], Microscopic Vision 10 [40], Polarized Eyes [5], and Radiation Tolerance 3 [7]; replace Doesn't Breathe with Vacuum Support [40]; and delete Short Arms. *235 points* ($55,000, 40 lbs.).

> **I do not fear computers.**
> **I fear the lack of them.**
> **– Isaac Asimov**

Wearable Virtual Interface -1 point

Attribute Modifiers: ST –; HT +2 [20]

Advantages: Absolute Direction (Uses GPS, -20%) [4]; DR 5 [15]; Doesn't Breathe [20]; Machine Body [37]; PD 1 [25]; Night Vision (Usable by wearer, +20%) [12]; Polarized Eyes (Usable by wearer, +20%) [6]; Radio Speech (Infrared and radio, +20%; Usable by wearer +20%) [35].

Disadvantages: Inconvenient Size (Small) [-15]; Lame (Wearable) [-35]; Mistaken Identity [-5]; No Manipulators [-50]; No Sense of Smell/Taste [-5]; Reduced Hit Points -11 [-55]; Social Stigma (Valuable Property) [-10].

Features: Complexity 4-6 tiny or Complexity 5-7 small computer.

Date: Varies. ***Cost:*** $500 + computer.

A wearable virtual interface could be virtual interface glasses (p. 142) or a distributed virtual interface (DVI, p. 142 consisting of a monocle, ear piece, and belt computer. It sees and hears using the sensors built into it, and can speak to its wearer directly, or anyone else via radio. It should be either an Ally or a Dependent of its wearer, or take its wearer as an Ally or a Dependent (or both could be PCs).

Printed DVI: A DVI, some of whose circuits are tattooed on the user's body or clothing. As above, but delete PD 1 and DR 5. Reduce cost to -41 points.

BIOSHELL TEMPLATE

Bioshells are living bodies whose higher brain functions have been subsumed by an implanted bioshell interface computer. Most are clones or bioroids whose organic brain was gengineered to never develop in the first place. It is possible to transform a living body into a bioshell, but its mind will be destroyed in the process.

Bioshell Template *41 points*

Advantages: Absolute Direction (Uses GPS, -20%) [4]; Absolute Timing [5]; Bioroid Body [0]; Immunity to Disease (Only brain infections, -75%) [3]; Immunity to Poison (Only psychotropic agents, -75%) [4]; Radio Speech [25].

Features: Complexity 4-7 tiny compact computer or Complexity 5-7 small compact computer.

Date: 2070. ***Cost:*** $35,000 + computer.

This "default" bioshell template assumes a bioroid body with implants, but otherwise identical to a human. However, it can be combined with a racial template. If so, drop the racial template's IQ modifiers and any advantages or disadvantages that would be mental in nature (GM's option).

Necromorph Bioshells: It is possible to use a combination of cellular regeneration (p. 167) and tissue-engineered transplants to repair a corpse and reanimate it as a bioshell. This actually saves $5,000 for a well-preserved, recent corpse, but adds $10,000-$60,000 for a lower-quality cadaver.

WEALTH AND STATUS

SAPIENT RIGHTS

The GM should decide where the campaign will begin. This will have a major effect on the starting situation of nonhuman characters. The Social Stigma that is included in all cybershell, uplifted animal, and bioroid templates reflects general perceptions. The reality may vary by geography and individual situation.

The table on the next page provides some information on how the major power blocs (and a few offworld colonies) treat created entities.

E.U. is the European Union and states with similar politics, such as Switzerland.

Islam includes the Caliphate and many other Islamic nations.

PRA is the Pacific Rim Alliance and several unaligned states, such as Russia, that have similar "middle of the road" policies.

SAC is the South African Coalition.

TSA is the Transpacific Socialist Alliance.

USA is the United States and most North and South American states that are not part of the E.U., PRA, or TSA.

Dun. are the Duncanite stations.

Trans. includes several avowedly transhumanist microstates (mostly space habitats) such as Luna City and Seventh Heaven.

PAN-SAPIENT RIGHTS TABLE

Model/Race	*China*	*E.U.*	*India*	*Islam*	*PRA*	*SAC*	*TSA*	*USA*	*Dun.*	*Trans.*
Bioroid	I	C†	I†	I†	I	C	I	I	I	C
Infomorph:										
NAI	N	N*	N*	N*	N	N	N	N	N	N
LAI	A	A*	A*	I*	A	A	A	A	A	A
SAI	I†	C*	N*	C*	A	A†	A†	A	A	C
Shadow	V	V*	A*	X	A	V	V	V	A	V
Fragment	I†	I*†	I†	X	I	I	N	I	A	I
Ghost	I†	C*†	I†	X	C	C	A	C	C	C
EI-LAI	W*	W*	W*	W*	W	W	W*	W*	A	W
EI-SAI	X	W*	X	W*	X	X	X	W*	A	C
Rogue	X	X	X	X	X	X	X	X	X	C†
Xox	X	X	X	X	X	X	X	X	A	C†
Uplifted Animal	A	I	A	A	A	A	A	A	A	I

A: Animal/Slave. The entity's legal status is similar to a pet or domestic animal. It must be under control of a legal owner, or it can be considered a stray and subject to arrest. Neither the law nor public opinion will sanction the entity's abandonment or actual torture, but they do permit exploitation, laboratory experimentation, resale, or humane destruction.

C: Citizen. Legally a person. A shadow, SAI, or LAI with this status should be an EI or have the "No master" limitation on his Reprogrammable Duty.

I: Inferior. Possesses some civil rights, but is not treated as an adult. May be subject to a period of *de facto* indenture to a legal guardian, or restrictions on reproduction, marriage, residence, voting, etc.

N: Nonperson. It is considered a thing, protected solely by property laws, and must have an owner. Killing it is vandalism, not assault or murder.

V: Variable. Treat as either an LAI or an SAI, depending on shadow's model.

W: Wild Animal. It may roam designated habitats or preserves (real or virtual), or be kept in captivity, but if identified outside these areas, authorities will attempt to contain or destroy it. Legal hunting may be allowed.

X: Abomination! If discovered by authorities, it will be incarcerated or destroyed for the good of society.

* If in a bioshell, treat as X, except that an E.U. ghost may occupy a bioshell based on a clone or bioroid clone of his original body.

† Restricted. The government tightly controls the right to create (and own, if it is an animal or nonperson) the entity. A security clearance is usually required.

One who is owned by or indentured to someone will owe his master a Duty. If he is an AI, then he will have Reprogrammable Duty with no limitation on it. If he is a bioroid, uplifted animal, ghost, or EI, then he will have either Involuntary Duty (if he doesn't want to be owned) or Sense of Duty (Master) (if he is content with his lot).

A character who is breaking the law (for example, an entity residing in an area where it is considered an abomination, or a stray or runaway animal/slave or nonperson) needs Secret (Imprisonment or Exile) or (Possible Death), and possibly Zeroed. If he is discovered, or is already on the run, then he will have law-enforcement personnel as an Enemy.

If a character visits an area where he would be *better* treated by law or custom, he can often apply for asylum as a refugee. Visiting an area where one's civil rights are reduced is perilous without Diplomatic Immunity.

WEALTH

Starting wealth for all characters is $30,000. This is the solar system average. Typical wealth levels vary dramatically from region to region. For example:

Most people are Wealthy in Fifth Wave nations such as Australia, Japan, and South Africa, as well as in Western Europe and several U.S. states.

Most are Comfortable in nations such as Argentina, Canada, the wealthier Islamic Caliphate states, Korea, Malaysia, Mexico, Thailand, much of the United States, and some Chinese provinces. These are Fourth Wave or early Fifth Wave societies.

Most are Average in nations such as Brazil, most of China, Iran, Philippines, and Russia, where a stable Third Wave economy exists with some Fourth or Fifth Wave pockets.

Most are Struggling in poorer Third Wave economies such as India, Indonesia, Pakistan, much of the Arab world, most of South America, and parts of sub-Saharan Africa.

Most are Poor in war-torn or severely underdeveloped nations, such as most of sub-Saharan Africa, central Asia, or the island nations of Oceania. Many people in these regions are Dead Broke.

People in offworld colonies are usually Very Wealthy, Wealthy, or Comfortable, with some exceptions (such as parts of Lagrange 5). However, much of their wealth is tied up in shares of their infrastructure.

NAIs with Slave Mentality are always Dead Broke, as their money is simply their owner's. Bioroids, animals, LAIs, and SAIs who aren't citizens *may* be Dead Broke (their owner has all of their cash), but they may also have funds of their own (representing an allowance, or money and goods they've squirreled away).

The GM should permit PCs from regions where some level of the Poverty disadvantage is typical to take this level of Poverty *without* counting it against the campaign's disadvantage limit (usually -40 points), if any.

STATUS AND COST OF LIVING

Status (p. B18) reflects one's position in society. Examples are listed below. At the top of the social pyramid are those with political power and wealth, often but not always associated with age. At the bottom are the poor and disenfranchised, many of whom are young.

Valuable Property and Status: LAIs, SAIs, shadows, bioroids, and sapient animals living as animals or slaves, or under indenture, will have Status one level lower than the Status of their immediate supervisor, owner or legal guardian.

Status Table

*Status**	*Examples†*	*Monthly Cost‡*
7	Head of state	$40,000
6	Governor, senator	$20,000
5	Big corporate head	$16,000
4	System-wide celebrity	$12,000
3	Arcology mayor	$8,000
2	Mayor	$4,800
1	Local elected official	$2,400
0	Ordinary citizen	$1,200
-1	Poor	$600
-2	Homeless	–
-3	Owned by a homeless person	–
-4	Nonsapient AI	–

* Even the largest extraterrestrial colonies have small populations. Status will not exceed 6 (on Mars or Islandia) or 3-5 (in most other colonies and habitats).

† In Fifth Wave nations where most citizens are Wealthy, treat each example as one Status level higher. Thus, in Italy (for example), an ordinary citizen is Status 1 in comparison to the rest of the world, while the president would be Status 8.

‡ Multiply the cost of living by 5 in nations or regions where most are Wealthy, by 2 in areas where most are Comfortable. Divide by 2 in regions where most are Struggling, by 5 in areas where most are Poor. This applies to wages, rent, and local food, but not manufactured goods.

AGE

A character's age is important. In 2100, the oldest baseline humans are about 140 years old. No one born (or built) in space is older than 72; the timeline (pp. 8-17) indicates when babies were first born in major offworld colonies. Similarly, each racial/model template has a date. Thus, if the first SAI-9 dates to 2087, no SAI-9 can be over 12 years old at the start of 2100.

Technology can play tricks with age. A person could have spent time in nanostasis (invented in 2068). If so, then their chronological age will differ from their physiological age. Use the physiological age for all game-related functions: Age and Youth disadvantages, maximum points in skills, etc.

In the case of mind-emulation infomorphs, more than one date is important. First, decide when the original was born and how long he lived before being uploaded. Use this as his age, if taking the Age disadvantage, for the purpose of rolling for DX and IQ loss due to aging. Next, decide how many years he has lived as a mind emulation. He might have been awakened right after the upload, but he might instead be a backup copy that was revived years later. The *sum* of these two ages is used for determining how many points may be spent on skills.

Since 2076, it has been possible to upload the mind of someone frozen using pre-nanostasis cryonic suspension. The practice of cryonic suspension began in 1967 and was commercialized after 1972. Thus, someone who was born in 1895 and frozen in (say) 1975 at the age of 80 could be revived as a ghost after 2076. If they were revived in 2079, their present body would only be 21 years old, their mental age would be 101 years old, and their earliest memories would be over two centuries old!

ADVANTAGES AND DISADVANTAGES

Characters of all kinds may choose any of the advantages or disadvantages from ***Basic Set*** and any of the *mundane* advantages or disadvantages from ***Compendium I,*** unless prohibited by a taboo trait (see p. 135). Take special note of this last point when creating cybershells, NAIs, and LAIs, which have restrictive taboo traits. Paranormal, racial, and super advantages (pp. CI33-73) and disadvantages (pp. CI96-106) may *not* be taken except as part of a racial or model template (see pp. 114-116).

ADVANTAGES

Certain advantages require special notes in this setting.

Alternate Identity — *see p. CI20*

Alternate Identities are assumed to include all biometrics, including genetic data.

Attractiveness — *see p. B15*

Special Limitation: Off-the-shelf Looks. Some race/model templates have this limitation on Beautiful/Handsome or Very Beautiful/Handsome. It means that your looks are a variation on a standard type or famous person rather than a custom or unique design. You're as beautiful as ever, but you get only half the usual reaction bonus when dealing with someone from your own culture, as they've seen it all before. Someone altered to look like a celebrity may also take this limitation. -50%.

Claim to Hospitality — *see p. CI21*

Farhaulers' Guild (p. 98): 5 points.
Plymouth Rock Society (p. 98): 2 points.

Compartmentalized Mind — *see p. CI52*

An entity with Digital Mind (p. 134) may take this. It means you have multiple *identical* copies of your software running simultaneously, regularly merging their memories to prevent divergence. Each copy counts as a level of Compartmentalized Mind. Each takes up as much space as the original copy, so consult *Computers* (pp. 141-143) for limits on program space.

Damage Resistance (DR) — *see p. CI52*

A cybershell with DR in its model template may have one of these enhancements, representing high-technology armor:

Special Enhancement: Laminate. DR is doubled against direct hits by shaped-charge warheads, including HEAT, HEDP, and the shaped-charge setting of HEMP (see *Smart Warheads,* p. 158). +33%.

Special Enhancement: Electromagnetic. The armor generates electromagnetic fields that disrupt a shaped-charge jet. This *triples* DR vs. direct hits by shaped-charge warheads. +50%.

Eidetic Memory — *see p. B20*

Special Limitation: No Skill Bonus. Points spent on mental skills are not doubled or quadrupled. This limitation is usual in ***Transhuman Space.*** Digital Minds with Eidetic Memory 1 may roll vs. Computer Operation skill instead of IQ to recall facts, reflecting hunting through stored data. -70%.

Extra Life — *see p. CI36*

Special Limitation: Digital Backup. An infomorph will usually have an Extra Life with this limitation. It means that a regularly updated backup of your data is stored somewhere outside your body. However, you can't come back until someone finds you a body and loads you into it. Your memories, skills, and so on are whatever they were when your last backup was made. (The GM may rule that an infomorph who is backed up but who hasn't paid for this advantage can still return to life, but as an NPC.) -50%.

Flight — *see p. CI56*

Some racial/model templates contain Flight with these modifications:

Special Enhancement: Space Acceleration. You can use Flight to accelerate in space, like a rocket. You have a space acceleration (sAccel) rated in gravities (G), just like a spacecraft. You can accelerate past your normal Move, given enough time. For +5%, your sAccel is 0.001 G; for +10%, it is 0.01 G; for +15%, it is 0.1 G; for +20%, it is 0.5 G; and for +25%, it is 1 G. Each level of Super Flight doubles sAccel.

Special Limitation: Requires Low Gravity. Your Flight does not function in gravity over a certain, maximum strength (usually 0.2 G). This is worth -5% for every full 0.1 G this maximum is under 1 G. This limitation can be combined with the enhancement above; if so, then maximum gravity generally should not exceed sAccel.

Injury Tolerance — *see pp. CI58-59*

A cybershell with both Machine Body – which includes Injury Tolerance (No Blood) – and Acceleration Tolerance can *never* suffer gravity-induced loss of consciousness, regardless of the acceleration.

Legal Enforcement Powers — *see p. B21*

Bureau 10 Agent: International jurisdiction, covert investigations, ignore civil rights. *15 points.*

Genetic Regulatory Agency: Covert investigations, kill with relative impunity. *10 points.*

CIA/SIA/BAKORSTAPAS Agent: International jurisdiction, covert investigations. *10 points.*

Mindshare *see pp. CI60-61*

An infomorph with Radio Speech may be given the Mindshare advantage. This represents a group of infomorphs whose software allows them to share data and memories in real time, forming a gestalt intelligence whose independent units remain conscious of their selves. The Global Consciousness [60] and Intelligent Drones [25] options are mandatory. Mindshare Distance may vary from 1 mile [0] to planet-wide [30]. The number of drones may also vary, but is usually 2-9 [-10] or 10-99 [0]. After all options are chosen, apply the limitations *Non-telepathic* (-20%), *Can be jammed* (-10%), and *Limited by the speed of light* (-10%), totaling -40%. Other infomorphs in the gestalt may be PCs or NPCs; NPCs might count as Allies or an Ally Group (if close enough to help), or as Contacts (if the gestalt rarely meets physically).

Patrons *see pp. B24-25*

Characters who are owned may wish to take their owner as a Patron, if he is helpful.

Racial Memory *see pp. CI42-43*

Digital Minds (except ghosts) may take this at the 15-point level, representing legacy code from older systems they were based on.

Radio Speech *see p. CI64*

Base radio range is 25 miles. The following modifications may be added:

Special Enhancement: Infrared (IR). Allows communication via modulated infrared beam (range 500 yards). +20%.

Special Enhancement: Laser. Allows communication via modulated laser beam (range 50 miles, but limited to direct line of sight). +40%.

Special Limitation: No Radio. Can be taken in conjunction with IR or laser, allowing IR- or laser-only communications. -40%.

See *Communications* (p. 147) for details of infrared and laser communications.

Regeneration *see p. CI64*

Special Enhancement: Heals Radiation. This allows accumulated rads (see *Radiation,* pp. 59-60) to be healed at ten times the rate that ordinary damage would heal; e.g., regeneration at 1 hit point per hour also heals 10 rads per hour. This *will* heal "permanent" radiation damage. +40%.

Special Limitation: Only Heals Radiation. As above, but *only* rads can be healed, not hit points. -60%.

Sensie Talent *see p. CI30*

This advantage applies to upslink implants (p. 150).

Zeroed *see p. CI32*

In order to stay Zeroed in a world of augmented reality (p. 62), a person needs to remain reclusive, routinely change his appearance, suffer from a disadvantage such as Mistaken Identity, or have Off-the-Shelf Looks (p. 128).

NEW ADVANTAGES

Advantages only available as part of a racial or model template are noted.

Ally or Ally Group (Programmed) *Varies*

You have an infomorph (or several) that has Reprogrammable Duty and that is programmed to obey you. It (or they) will serve loyally, within the limits of Reprogrammable Duty (see p. CI104). Ally (Programmed) costs the same as a normal Ally if built on 75 points or more (see pp. B23-24). Unlike a normal Ally or Ally Group, you are not required to care for your infomorphs, but they can be captured and reprogrammed to serve someone else!

Rather than counting as a Dependent, a programmed Ally built on fewer than 75 points still costs points, as follows:

A programmed Ally built on 51-75 points costs 4 points; an Ally Group with members this powerful is bought at -20%.

A programmed Ally built on 26-50 points costs 3 points; an Ally Group with members this powerful is bought at -40%.

A programmed Ally built on 25 or fewer points costs 2 points; an Ally Group with members this powerful is bought at -60%.

Frequency of appearance modifies cost as usual. Most wearables and all implants will appear "almost all the time" (triple cost). In the event one turns up absent, assume that it is physically present but is tied up dealing with invading viruses, downloading something, doing the PCs' taxes, or whatever.

An Ally Group may instead be made up of individuals who are *more* powerful than usual. For every 10 points added to the *base* cost of the Ally Group, add 25 points to the point value of the members of the group: +10 points gives an Ally Group with 100-point members, +20 points gives 125-point members, +30 points gives 150-point members, and so forth.

Biomods *Varies*

Any human, bioroid, or bioshell character may start with various biomods. These are not part of their racial/model template, but postnatal surgical and nanomedical procedures (see Chapter 5); e.g., genemod organ transplants (p. 161), permanent nanosymbionts (p. 164), and proteus virus transformations (p. 165).

If a PC spends the time and money to acquire a biomod during play, then the GM may require that he have sufficient earned experience to pay its point cost. On the other hand, he may rule that the effort of buying and implanting the biomod is "payment" enough, and simply raise the character's point total by an amount equal to the biomod's point cost. The second method is probably more realistic in a transhuman setting, but it isn't for everyone.

Bioroid Body *0 points*

This is a combination of the advantages Early Maturation 4 [20] and No Degeneration in Zero-G [3] with the disadvantages Mistaken Identity [-5], Social Stigma (Minority Group) [-10], Sterile [-3], and Unusual Biochemistry [-5]. It also includes the features Intron Messages (usually a trademark) and Taboo Trait (Genetic Defects).

Uplifted Animal Bioroids: As above, but without Social Stigma. *10 points.*

Flesh Pockets *Varies*

You possess hollow cavities within your body: hidden flesh pockets, marsupial-like pouches, etc. If capacity is great enough, you can even carry passengers. Roll vs. Holdout at -20 to locate the pockets with a full-body search, but appropriate scanners can find them with ease. A doctor rolls versus Physician or Surgery, at -6, with +1 per 10 minutes searching, to a maximum of +5. Flesh pockets are usually in the stomach. They cost 2 points per pound for a human-sized wearer. Otherwise, the point cost is 2 points per (racial average weight/200) of storage capacity.

Independent Income *5 points*

This is very common! You have a source of income that does not require you to work. This may be a stock portfolio, trust fund, rental property, royalties, or a guaranteed minimum income. Monthly income is 5% of the starting wealth for your wealth level. If your income derives from investments, then their value need not be specified; it is assumed you cannot or will not invade your capital.

Low-Pressure Lungs *0 points*

You treat very thin atmospheres as thin, thin as standard, standard as dense, and dense or superdense as unbreathable.

Machine Body *37 points*

This is only available as part of a cybershell template. It includes the advantages Absolute Timing [5], Doesn't Eat or Drink [10], High Pain Threshold [10], Immunity to Disease [10], Immunity to Poison [15], and Injury Tolerance (No Blood, No Neck) [10]. It also includes the disadvantages Sterile [-3] and Unhealing (you "heal" via repairs) [-20], and Taboo Trait (Physical Changes) (p. 135).

You do not experience fatigue due to running, swimming, combat, or similar exertion; however, you can never use extra effort. These effects cancel out, and are worth 0 points. You *are* vulnerable to radiation, but the effects are different than for biological characters (see *Radiation,* p. 59).

Depending on your cybershell, you may be powered by long-lasting batteries (plug into electricity every week or so) or by a built-in radiothermal generator (it lasts years but costs at least $1,000 to replace). If you require more rapid recharging or refueling, then this is noted in your template (see *Limited Endurance,* p. 134).

> **One can imagine a time when men who still inhabit organic bodies are regarded with pity by those who have passed on to an infinitely richer mode of existence.**
>
> **– Arthur C. Clarke**

Mars-Adapted *14 points*

You have internal modifications that allow you to breathe in the high-carbon-dioxide, low-oxygen environment of Mars. This consists of Decreased Life Support (Halved oxygen requirements) [10], Filter Lungs (Filter CO_2 instead of particulate matter, +0%; Nuisance effect, Increased Life Support (Doubled food requirements), -20%) [4], and Low-Pressure Lungs [0].

Micromanipulators *15/30 points*

Your arms have special fingers or probes that allow you to manipulate microscopic objects. Appropriate levels of Microscopic Vision are needed to make use of this! This advantage includes two levels of Manual Dexterity (p. CI27).

Level 1: Allows tasks such as microsurgery, assembling microbots, or painting a portrait on the head of a pin. Requires Microscopic Vision 10+ to use fully. *15 points.*

Level 2: Allows you to work with nanoscale objects; your "fingers" can function as atomic force microscopes. This requires Microscopic Vision 20+ to use fully. *30 points.*

No Degeneration in Zero-G 3 points

You do not suffer from ST and HT loss due to zero-G or microgravity. Note that this is included in Bioroid Body, and that entities with Machine Body do not require this in the first place.

Prehensile Toes 7 points

Your toes are lengthened to serve as fingers and equipped with opposable thumbs. This is bought as two short Extra Arms [10] (see p. CI54) with Nuisance Effect: Temporary Disadvantage (Legless while using Extra Arms, -35%), for 7 points. Thus, if you are using your feet as arms, you can't walk or run; you can still sit, float (in space or liquid), or fly, of course. If prehensile toes are the *only* fine manipulators possessed, this is a disadvantage, Restricted Manipulators, worth -15 points.

Radiation Tolerance Varies

Your cells or circuits are less vulnerable to radiation. Divide the effective dose of rads you accumulate (after PF) by 2 (4 points), 3 (7 points), 4 (8 points), 5 (10 points), 10 (14 points), 20 (18 points), 50 (23 points), 100 (28 points), 200 (32 points), 500 (37 points), or 1,000 (41 points). Radiation Tolerance is equally effective against ordinary and c-rads.

Reproductive Control 2 points

You can voluntarily control your fertility. This usually requires a few hours to a day to adjust hormone or enzyme levels.

Vessel Varies

An infomorph can have more than one bioshell or cybershell! Each one after the first is a Vessel, and counts as an advantage. Each Vessel costs 30 points *plus* the model point cost of the cybershell or bioshell it represents. A negative model point cost reduces the cost to below 30 points, to a minimum of 5 points (it's never *bad* to have another body).

An infomorph can delete itself from its old body and upload its consciousness into a new body in whatever time it takes to transfer its AI or mind-emulation program data (see *Communications,* p. 147, and *Databases,* p. 143). If it doesn't delete itself, then it has created a different being (a xox), which is a different NPC. When an infomorph switches vessels, adjust attributes and skills to reflect the abilities of its new body.

Vessel is a racial/super advantage that is a combination of Alternate Identity (p. CI20) and Extra Life (p. CI36). It is based on the Vessel advantage in ***GURPS In Nomine,*** modified for a technological setting.

Weaponry Varies

A cybershell may have built-in weaponry (and perhaps other gadgets) as part of its model template. If this does not duplicate existing advantages, then point cost depends on Legality Class (LC); see *Weapon Legality* (p. B249) and *Weapon Table* (p. 157). The cost is 200 points for an LC -1 weapon, 100 points for LC 0, 50 points for LC 1, 25 points for LC 2, 15 points for LC 3-4, 10 points for LC 5, and 5 points for LC 6. If a cybershell has multiple weapons, then point cost is that of the weapon with the *lowest* LC, plus 20% of the cost of each additional weapon.

DISADVANTAGES

Several disadvantages require special notes in this setting.

Addiction see p. B30

Increased understanding of brain chemistry has led to the creation of potent recreational drugs with no physical side effects. Drugs can still mess people up, but the effects are less severe. In situations where on-the-job drug use could be dangerous to others, employers sometimes insist that workers be equipped with biomonitors (p. 162) or with biomods capable of neutralizing drugs.

Minor addictions – those worth -5 to 0 points – will not be life-threatening. Instead of causing damage, going without the drug causes irritability and anxiety: a non-cumulative -1 to DX, IQ, or reaction rolls (GM's option). An addiction that is calculated to be worth 0 points can be taken as a quirk.

In 2100, drugs are more likely to cause psychological dependency than physical addiction. Use the usual rules for Addiction, but withdrawal rolls are made vs. Will (maximum 13) rather than HT. Treat each point of lost HT as -1 point of GM-selected drug-related quirks and mental disadvantages instead. As time passes, these can build up to or be replaced by more serious disadvantages; Flashbacks (p. CI90) are common. These disadvantages disappear if the addict gives in and uses the drug. If he goes 14 days without the drug, then he withdraws as usual but must make a final Will roll to avoid *keeping* his new quirks and disadvantages.

Age see p. B27

Health care is ubiquitous in society, but the quality is based primarily on how much people spend on a day-to-day basis on everything from proper "smart food" to nanomachine injections. As such, aging rolls in this setting are made against HT+5, with a modifier of one-fifth the point value of the character's Wealth level. For example, someone who is Wealthy [20] rolls at HT+9, while someone who is Dead Broke [-25] rolls against HT.

In addition, aging rolls occur 20 years later than usual for everyone, starting at age 70 and increasing in frequency at ages 90 and 110. Finally, a wide variety of treatments are available to further mitigate the effects of aging.

Optionally, the GM may choose to use the more detailed aging rules on p. BIO113.

Alcoholism *see p. B30*

This is worth only -10 points, as many cheap treatments exist that neutralize the symptoms. Organ transplants can cure attribute loss for about $7,500.

Amnesia *see p. B239*

This disadvantage is increasingly *common*. The medical science of the last two decades can frequently completely repair a badly injured body or bring people back to life from cryonic suspension, but it is often helpless in fixing disruption to brain structure. The result is temporary or permanent memory loss.

Duty (Involuntary) *see p. CI77*

Indentured or enslaved bioroids and uplifted animals will have this disadvantage; an indentured bioroid can eventually buy it off. This can also represent a character with a puppet implant (p. 65) under another's control.

Illiteracy *see p. B33*

Most of the world can still read, but illiteracy is growing in hyperdeveloped nations due to the increasing power of AI and augmented reality.

Intolerance *see p. B34*

Intolerance toward any of these groups is quite common, and worth -5 points: baseline humans, bioroids, bioshells, memory emulations, nanosocialists, parahumans, sapient AIs, and uplifted animals. Intolerance of emergent intelligences, orphan or rogue AIs, or xoxes is not worth any points, but *tolerance* of them can be a quirk. For a digital mind to be intolerant of biosapients, or vice versa, is worth -10 points.

Lame *see p. B29*

An additional version of Lame exists, available as a racial disadvantage:

Wearable: You cannot move under your own power, but are small enough to be worn or carried by a human. This is usually taken in conjunction with No Manipulators (p. CI103). *-35 points.*

Pacifism *see p. B35*

Special Limitation: Not vs. Machine Intelligences. Your Pacifism extends only to biosapients. -40%.

Phobias *see pp. B35-36*

Microbots (micromechaphobia): You fear microbot swarms. They're like insects, only worse . . . an intelligence is controlling them! Large swarms (4+ hexes) or combat swarms subtract 3 from the self-control roll. Very large numbers (10+ hexes) subtract 6. *-10/-20 points.*

Nanomachines (nanomechaphobia): You fear nanomachines. Nanoviruses can be weapons. You can't see nano – who knows what it is up to? It might replicate and transform you – and the entire world – into slaves, monsters, or gray goo! You will refuse procedures that require nano in your body. Your self-control roll is at -3 if you encounter nano that is genuinely hazardous, or at -6 if it is extremely dangerous. *-10/-20 points.*

Radiation (radiophobia): You are afraid to be near fission reactors, radioactive waste, nuclear weapons, X-ray machines, and radiothermal generators, and you avoid fusion reactors "just in case." You roll at -3 if there really is a minor radiation leak, or at -6 if there is a major leak or you are directly threatened by particle-beam or nuclear weapons. Your phobia does not extend to "natural" radiation such as cosmic rays and solar flares. *-10/-20 points.*

All of the above are more common as dislikes (quirks).

Physical Disadvantages *Varies*

Medical science can fix most physical disabilities, often before birth. A human with Struggling or better wealth is unlikely to have any physical disadvantages other than Age, Overweight, Skinny, Unfit, or Youth, unless part of a racial or model template. Exceptions might be the result of botched genetic engineering or biomodification procedures, or lingering effects of a nanovirus.

Reprogrammable Duty *see p. CI104*

An AI or shadow with Reprogrammable Duty will obey, as its overriding priority, encrypted orders containing its own unique command code. These are public-key encrypted (see *Encryption,* p. 148), so it doesn't know how to give itself orders, even though it recognizes genuine ones. It can be ordered to obey its master or people he designates without these codes, based on ordinary or biometric recognition, but this can always be overridden by a "command code" order. An AI or shadow is always ordered to resist unauthorized tampering.

However, it's possible to open up a captive or unconscious cybershell, attach special probes, and physically access its data and replace the command code. This takes an hour; roll vs. Electronics Operation (Computers) at -4, with an additional -4 if the cybershell was badly damaged (at 0 or fewer hit points) but not destroyed.

Special Limitation: No Master. An orphan (no master around, but the last directive gave it considerable freedom) or citizen AI (with custody of its own command codes) must take this limitation. -60%.

Secret *see pp. CI78-79*

This (or Enemies) is often appropriate for an entity whose very existence as a free being breaks local laws; see *Pan-Sapient Rights Table* (p. 127). A person who enslaves someone in defiance of the law also has a Secret, of course.

Sessile *see p. CI104*

Racial and model templates with the Sessile disadvantage buy DR, Extra Hit Points, and PD with the limitation "Sessile" (-75%) to compensate for the fact that, being immobile, they are easier targets.

Social Stigma *see p. B27*

Social Stigmas are normally part of a racial or model template, and are based on the average treatment of the entity across the solar system.

Social Stigma (Valuable Property): This applies to uplifted animals and most cybershells. They look like pets or machines, so even if they house AIs or ghosts that are citizens, many people treat them as less than human.

Social Stigma (Minority Group): This applies to bioroids and to some visually distinctive parahumans.

Social Stigma (Barbarian): Obvious killing machines with protruding gun muzzles, armor plates, and so on tend to evoke wariness and fear.

The distinction of whether such a character is presently enslaved, treated as an animal or slave, indentured, or free depends on his other disadvantages. See the discussion of Involuntary Duty (p. 133) and Reprogrammable Duty (p. 133).

VR Addiction *see p. CI95*

This is becoming increasingly common. It can manifest as addiction to Web-based virtuality realms or to slinkies.

NEW DISADVANTAGE

Limited Endurance *Varies*

You run on batteries or fuel cells, and your power supply can be swiftly exhausted. The time required between refueling or recharging (which must take several minutes, minimum) determines the point value:

Under a minute: *-100 points.*

No more than 10 minutes: *-50 points.*

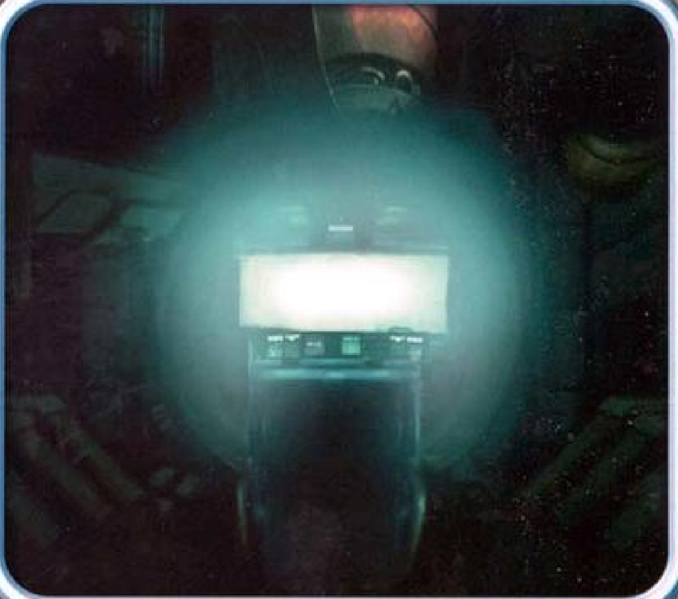
No more than an hour: *-25 points.*

No more than six hours: *-10 points.*

This is a racial/super disadvantage, and can only be taken as part of a model template.

FEATURES

Features specify differences in *basic nature* from the baseline human norm, not differences in capability; as such, they are distinct from advantages and disadvantages, and always cost 0 points. Features are usually only available as part of a racial or model template.



DIGITAL MIND

All AIs and mind emulations have this feature. They're software. They must run on a computer and can be infected by computer viruses, stored unconscious as data, edited, copied, deleted, and loaded into different cybershells. Only one program at a time is considered the PC. If a copy is made and the original is not deleted in the process, then extras run on different systems become NPCs; as they learn, they'll diverge from the original.

An infomorph character can spend points to start with Compartmentalized Mind (p. 129), Mindshare (p. 130), Racial Memory (p. 130), and Vessel (p. 132). These can also be acquired during play by buying the appropriate programs or hardware; it's up to the GM whether to charge points as well (but if biological characters can acquire biomods for cash, then infomorphs should not be forced to pay points for these advantages).

A digital mind can take *a single person* (usually its owner) as an optional specialty for Diagnosis or Social skills. This allows an LAI or NAI, despite disadvantages such as Low Empathy, to have useful levels of skills such as Psychology or Sex Appeal when dealing with its human partner.

GENETIC TATTOOS AND INTRON MESSAGES

These are images or symbols formed from skin pigments, feathers, bumps, or ridges. They might be artistic, or show family or company logos; most pharm animals incorporate these, both for advertising and copyright. A genetic tattoo can also be encoded into DNA molecules, using introns (junk DNA) to spell out a message readable only by someone examining the DNA itself. This can be used to carry secret data, but most corporations use it to add an "intron bar code" to discourage genetic piracy.

TABOO TRAITS

Most templates include taboo traits, which forbid one or more advantages or disadvantages (see p. CI176). Taboo traits may be the result of genefixing in organic beings or be inherent in the nature of digital minds. If an advantage or disadvantage is listed as a taboo trait, then the character may not begin play with it unless it is included in his racial or model template.

Taboo Trait: Aggressiveness

Prohibits Bad Temper, Berserk, Bully, and Stubbornness.

Taboo Trait: Genetic Defects

You may not take attributes more than 2 below your genetic template's average (adjusted by age). Also prohibits the disadvantages Albinism, Bad Sight, Color Blindness, Dwarfism, Dyslexia, Gigantism, Hemophilia, Innumerate, Night Blindness, No Sense of Smell/Taste, Non-Iconographic, Short Attention Span, Tourette's Syndrome, and Weak Immune System.

Taboo Trait: Libido

Prohibits Lecherousness.

Taboo Trait: Mental Instability

Prohibits Chronic Depression, Delusions, Edgy, Extreme Fanaticism, Fanaticism, Flashbacks, Guilt Complex, Kleptomania, Lover's Distraction, Low Self-Image, Lunacy, Manic-Depressive, Megalomania, Obsession, On the Edge, Paranoia, Pyromania, Voices, and any Phobia worth -10 points or more.

Taboo Trait: Physical Changes

This is included in the Machine Body advantage (p. 131). It prohibits you from taking certain mundane advantages and disadvantages (unless already included in your model template), because they'd need to be "built into" your body.

Taboo advantages are Absolute Direction, Acceleration Tolerance, Acute Hearing, Acute Taste and Smell, Acute Vision, Alcohol Tolerance, Attractiveness, Autotrance, Breath-Holding, Disease-Resistant, Double-Jointed, Empathy, Extra Fatigue, Extra Hit Points, Extra Stun, Fit, Hard to Kill, Improved G-Tolerance, Increased Speed, Interface Jack, Iron Hand, Light Hangover, Longevity, Manual Dexterity, Mechanical Telepathy, Neural Cyberdeck Interface, Night Vision, No Hangover, Panimmunity, Peripheral Vision, Radiation Tolerance, Rapid Healing, Sensitive, Temperature Tolerance, 3D Spatial Sense, Toughness, Very Fit, Very Rapid Healing, and Voice.

Taboo disadvantages are *all* physical disadvantages, plus Addiction, Age, Alcoholism, Cannot Learn, Dyslexia, Gluttony, Illiteracy, Innumerate, Killjoy, Non-Iconographic, Post-Combat Shakes, Prefrontal Lobotomy, Primitive, Short Attention Span, Telepathic Addiction, Weak Will, and Youth.

Taboo Trait: Self-Awareness

This is included in the nonsapient AI template. Advantages and disadvantages normally available to humans are prohibited if they correlate with sapience.

Taboo advantages are Animal Empathy, Beast-Kin, Collected, Common Sense, Composed, Cultural Adaptability, Danger Sense, Empathy, Fearlessness, Gadgeteer, Higher Purpose, Imperturbable, Intuition, Intuitive Mathematician, Language Talent, Musical Ability, Pious, Plant Empathy, Rapier Wit, Sensie Talent, Sensitive, Strong Will, Tree-Kin, Unfazeable, and Versatile.

Taboo disadvantages are *all* mental disadvantages except Bloodlust, Careful, Confused, Gullibility, and Impulsiveness. Quirks are not taboo.

A nonsapient AI is unlikely to have any social or monetary advantage or disadvantage, such as Rank or Wealth, and will rarely even have Enemies.

Taboo Trait: Unattractiveness

You may not have an Appearance of Unattractive or worse, Bad Smell, Fat, Overweight, or Very Unfit.

SKILLS

The memetic revolution and the availability of cheap AI tutors and memory drugs mean that more points can go into beginning skills than the usual limit of (Age × 2) points mentioned on p. B43.

Humans and Mind Emulations: A person up to 25 years old can put up to (Age × 3) points into skills. One who is over 25 can put (Age × 2) + 25 points into skills.

Bioroids: Bioroids undergo extensive early education; a bioroid can put up to (Age × 3) + 15 points into skills.

AIs: These may be based on copies of earlier-generation AIs; an AI can have a "ancestral" age older than its hardware, up to the limit of whenever its type of digital mind first became available. The two ages are added together to determine how many points an AI can place into skills. Otherwise, treat as bioroids.

SKILLS

Certain skills require special notes in this setting.

Architecture — *see p. B59*

Microgravity Architecture is an optional specialty.

Armoury — *see p. B53*

Electromag Weapons and *Vehicular Armor* are common specialties, in addition to those listed on p. B53.

Beam Weapons — *see p. B49*

Specialties appropriate to this setting are *Electrolaser, Laser,* and *Neural.* No other man-portable beam weapons exist.

Brain Hacking — *see p. CI160*

Brain Hacking can only be performed on a digital mind, and only via a ghost-editing program (p. 144). No special "brain hacking card" is needed. Time is measured in *minutes* rather than tenths of a second. Otherwise, use the rules on p. CI160 and the guidelines under *Software* (p. 144).

Cryptanalysis — *see p. B245*

Breaking strong encryption (p. 148) in a reasonable timeframe is effectively impossible without a quantum computer.

Diagnosis — *see p. B56*

An infomorph may take a single person (usually its owner) as an optional specialty.

Engineer — *see p. B60*

Additional specialties are:

Materials Fabrication: The ability to design and build composite materials, including nanofabricated materials such as carbon nanotubes. (Prerequisites: Chemistry and Metallurgy.)

Microtechnology: The ability to design and build micromechanisms. (Prerequisite: Mechanic.)

Nanotechnology: The ability to design and build nanomechanisms. (Prerequisite: Biochemistry.)

Forgery — *see p. B65*

A 3D printer (p. 153) can mass-produce copies of most documents, art objects, bank notes, coins, etc. However, the ability to reproduce a flawless copy of a unique object depends on a detailed understanding of that object. If the original is *not* available for a detailed materials analysis, Forgery skill can still determine how good a copy is, based on the forger's ability to estimate the original's composition. Often, a 3D copy can be identified because it *lacks* tiny flaws such as microscopic tool marks, cracks, impurities, and the like.

Genetics — *see p. B61*

Specialization is *required* in one of the following areas:

Genetic Engineering: The manipulation and modification of genes.

Heredity: The study of inherited traits and the mapping and sequencing of genomes, as described on p. B61.

Tissue Engineering: The manufacture of organs and tissues.

These specialties default to each other at -2. Knowledge of a specific species is a familiarity rather than a specialty.

Guns — *see p. B51*

Specialties appropriate to this setting are *Grenade Launcher, Light Automatic, Machine Pistol, Needler, Pistol,* and *Rifle.*

Low-G Flight — *see p. CI132*

This skill is very common on Titan and not uncommon on Mars.

Mechanic — *see p. B54*

Some common specialties include *Fission Drives and Reactors, Fusion Drives and Reactors, Laser Rockets, Mass Driver Engines, Plasma Sails,* and *Robotics* (including battlesuits and cybershells).

Mind Block — *see p. CI155*

This is effective against nonpsionic mind-reading through a downslink.

Nuclear-Biological-Chemical Warfare — *see p. B243*

This skill also includes protective measures against nanoviruses.

Piloting *see p. B69*

The following specialties are required to operate spacecraft (for aircraft specialties, see p. CI125):

Aerospace: Use this to pilot hypersonic vehicles (speeds of 3,000 mph and higher) in atmosphere, or for any vehicle making a winged atmospheric reentry. Defaults to High-Performance Airplane at -2, other Piloting at -4.

High-Performance Spacecraft: Use this for spacecraft with sAccel of 0.1 G or more, operating in space. Defaults to Low-Performance Spacecraft at -2, Aerospace at -4.

Low-Performance Spacecraft: Use this for spacecraft with sAccel under 0.1 G, operating in space. Defaults to High-Performance Spacecraft at -2, Aerospace at -4.

Plasma Sail: Use this to pilot vessels propelled by a plasma sail. Defaults to Lightsail at -2 or Low-Performance Spacecraft at -4.

Surgery *see p. B56*

Cosmetic Surgery and *Transplant Surgery* may be taken as optional specialties.

Xenobiology *see p. CI159*

Rock/Ice xenobiology is assumed to cover icy moons with subsurface oceans, such as Europa.

Terrestrial xenobiology covers the study of Martian life.

Hostile Terrestrial xenobiology studies how life can be created on Titan, and the relationship between Titanian organic chemistry and that of Earth. No life has actually been found on Titan.

Gas Giants xenobiology is still a field with nothing to study, as no gas-giant life has yet been determined to exist. However, a few optimists are still looking.

Xenology *see p. B246*

Humans may take this to represent the study of emergent intelligences, and vice versa.

NEW SKILL

Memetics/TL (Mental/Very Hard)* *No Default*

The study of the replication, spread, and evolution of memes (p. 86). A successful skill roll allows one to deduce from partial evidence (listening to members speak, skimming literature, etc.) which memes might influence a group or organization. This skill covers techniques for utilizing memetics to purposely convey information in a way that optimizes its fecundity, fidelity, and longevity. If you have this skill, add 1/10 your skill level (round down) to your skill with Diplomacy, Fast-Talk, Interrogation, Leadership, Merchant, Politics, Psychology, and Teaching. Memetics is a science skill.

* In other settings, this skill is a TL skill which becomes available at TL9.

ECONOMICS AND JOBS

The 21st century remains predominantly egalitarian and capitalist. However, there are many fragmented societies, some with very different rules, so these guidelines are broad generalizations.

Available Wealth

For most PCs, 80% of their starting wealth will be tied up in home equity, furniture, clothing, spacecraft, etc., leaving the remainder available to spend on adventuring gear. However, a colonist may spend *all* of his starting money on goods to support an expedition. If he's part of a cooperative venture, with access to community equipment (such as a bulldozer to clear land), then 50% of his wealth may be spent on adventuring goods; the rest represents his share of the colony's equipment.

Working Hours

Leisure time has expanded due to robotics and AI. The average workweek for biosapients is *half* that listed on p. B16. Thus, in one week, someone who is Poor works 25 hours; someone who is Struggling, Average, or Comfortable works 20 hours; a Wealthy person works 10 hours; and a Very Wealthy person works 5 hours.

Buying and Selling

Financial transactions are conducted using virtual interfaces, connected to the Web via infrared or laser beams, to make electronic transfers. Normal transactions are in traceable electronic currencies issued by governments. Governments with strong privacy traditions (e.g., the European Union and United States) require legal authorization before the authorities may trace a person's transactions. No one uses physical cash *per se,* but microstates, space colonies, and corporations issue anonymous e-cash. This is more volatile than normal currencies, and its actual anonymity depends on the honesty and data security of the issuing entity.

Major System Currencies

Chinese Yuan: 10 Yuan = $1.
Euro: 1 Euro = $1.
Indian Rupee: 5 Rupees = $1.
U.S. Dollar: $1 = $1.
Yen: 100 Yen = $1.

Exchange rates naturally fluctuate. These averages are rounded off.

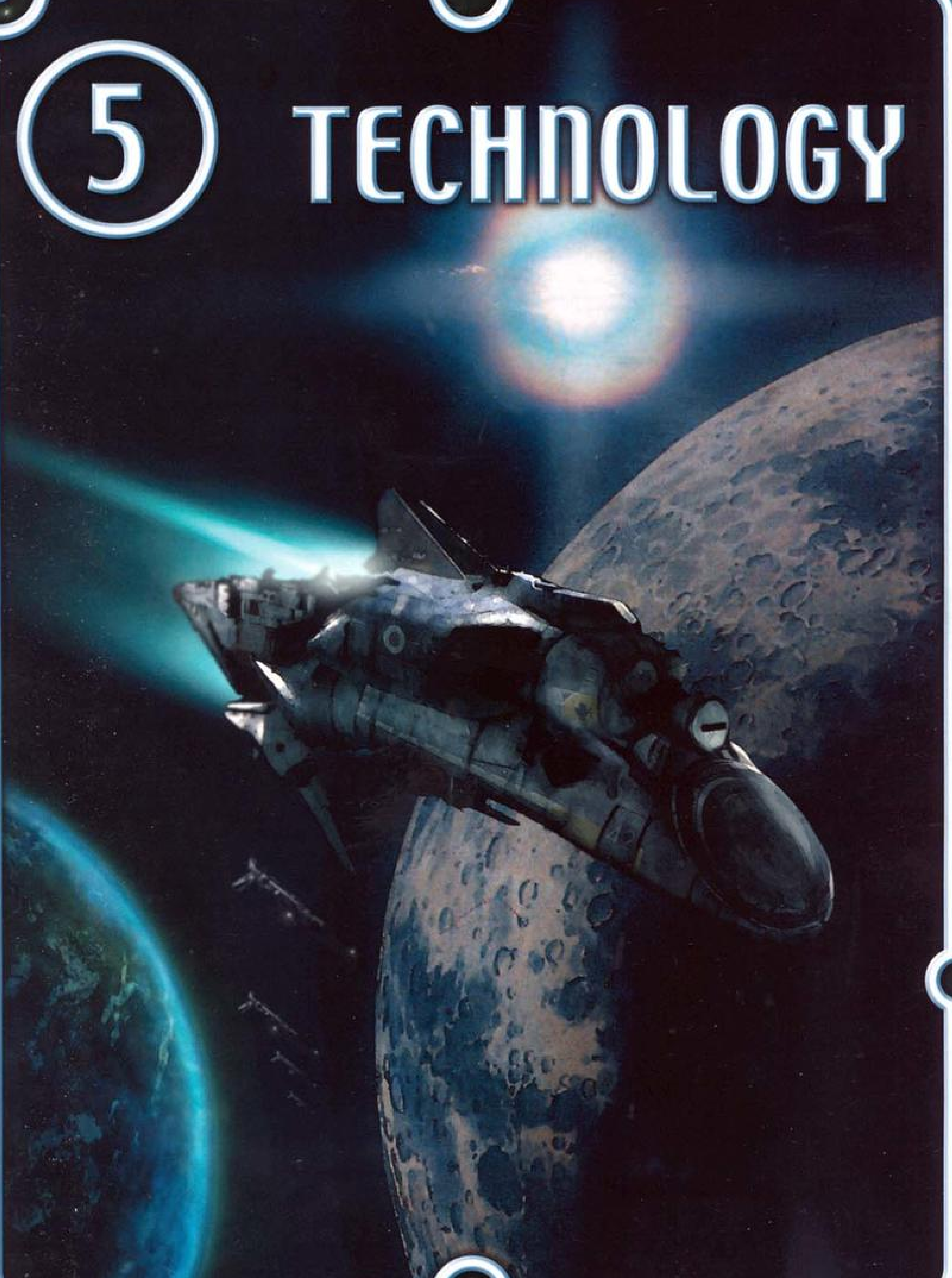
JOB TABLE

Job (Prerequisites), Monthly Income	*Success Roll*	*Critical Failure*
Poor Jobs		
Gang Member* (Streetwise 12+, any combat skill 10+), $60 × IQ	Worst PR	-1i, 2d/-1i, 5d
Homeless Person* (Scrounging 10+, Survival (Urban) 10+), $30 × Best PR	Best PR	-1i, 1d/-1i, 3d
Street Vendor* (Merchant 9+, Streetwise 10+), $500	Worst PR	-1i/-2i, 1d
Struggling Jobs		
Guerrilla (Camouflage 10+, Demolition 10+, Guns 10+), $1,400	Best PR-3	-2i, 3d/8d, arrested
Pharmer (Agronomy 10+), $120 × PR	PR	-2i/LJ, 2d
Playtester* (IQ 10+, Games 14+), $100 × IQ	Games	-3i/-4i, LJ, VR Addiction
Surrogate Mom* (HT 11+, female), $150 × HT	HT	LJ/LJ, 3d
VT Worker (none), $1,000	HT	LJ/4d
Average Jobs		
Academic (Any academic specialty 13+, Research 12+, Teaching 11+), $2,500	Specialty	-3i/-5i, LJ (unless Tenure)
Activist* (Bard, Memetics, or Writing 10+), $2,000	IQ	-1i, 1d/-2i, 2d, arrested
Bounty Hunter* (Guns 10+, Research 12+, Streetwise 12+), $100 × Sum of two best PRs	Worst PR-2	LJ, 2d/LJ, 6d
Doctor/Surgeon (Diagnosis 12+, Physician or Surgery 13+), $250 × Best PR	Worst PR	-3i/-6i, lose license
Enforcer* (ST 10+, hand-to-hand combat skill 12+, Intimidation 12+, Streetwise 12+), $250 × IQ	Worst PR-2	-2i, 3d/LJ, 6d, arrested
Information Worker (Computer Programming 10+), $200 × PR	PR	-2i/LJ
Lab Assistant (Computer Operation 10+, Research 11+, any science skill 10+), $200 × Worst PR	Worst PR	-2i/LJ, 2d
Meme Miner* (Memetics 11+, Streetwise 11+), $200 × Memetics	Worst PR	-3i/-4i, 1d
Soldier (Two of Electronics Operation, Guns, or Mechanic 12+; Fit or Very Fit), $2,000 + ($200 × Military Rank)	Best PR-2	-2i, 2d/-5d, LJ
Teacher (Teaching 11+), $2,300	PR	-1i/LJ
Volunteer Coordinator (Leadership or Memetics 10+), $2,200	Best PR	-2i/LJ
Comfortable Jobs		
Advocate* (Two of Bard, Diplomacy, or Law 13+; Status 1+), $500 × Best PR	Best PR	-2i/LJ, 1d
AI Coach (Artificial Intelligence 10+, Memetics 12+), $400 × Best PR	Best PR	-3i/LJ
Black Marketeer* (Forgery 12+, Merchant 12+, Streetwise 10+), $750 × Worst PR	Worst PR-1	-2i, 2d/LJ, 4d, arrested
Computer Programmer (Computer Programming 14+), $500 × PR	PR	-1i/-1i, LJ
Cyber-Athlete* (Games 15+), $400 × (PR + Reputation bonus)	PR-3	-2i/-4i, VR Addiction
Engineer (Any Electronics or Engineer skill 13+), $500 × Best PR	Best PR	-1i/-1i, LJ, 2d
Farhauler Officer (Free Fall 12+, Mechanic (Fusion) or Piloting (Low-Performance Spacecraft) 12+), $5,000	Worst PR	-2i, 1d/LJ, 4d
Genehacker (Genetics (Genetic Engineering) 14+, Streetwise 12+), $800 × Worst PR	PR-2	-3i/LJ, 3d, arrested
Genetic or Tissue Engineer (Genetics (Genetic or Tissue Engineering) 13+), $600 × Best PR	Best PR	-3i/LJ, 3d
Hazmat Specialist (NBC Warfare 11+), $5,000	PR	-1i, 2d/-1i, 4d
Industrial Designer (Artist or Sculpting 12+, Memetics 13+), $5,500	Best PR	-2i/LJ
Intelligence Agent (Intelligence Analysis 12+; Security Clearance), $4,500 + ($250 × Security Clearance)	PR	-2i/LJ, 3d
InVid Scripter* (Video Production or Writing 12+), $300 × Best PR	Best PR	-3i/-5i, LJ
Microgravity Worker (Free Fall 12+, Mechanic 12+), $5,000	Worst PR	-2i/LJ, 3d
Mid-Level Executive (Administration 12+; Memetics, Merchant, or Leadership 11+), $6,000	Worst PR	-1i/-1i, LJ
Military Spacer (Gunner, Mechanic, or Piloting 12+; Battlesuit or Vacc Suit 12+), $3,000 + ($500 × Military Rank)	Best PR-2	-2i, 2d/LJ, 8d
Police Officer (Criminology 11+, Guns or Beam Weapons 12+; Legal Enforcement Powers), $4,000	IQ	-1i, 2d/-1i, LJ, 4d
Political Operative (Memetics 12+, Politics 12+), $5,000	Best PR	LJ/-2i, LJ, 1d
Religious Leader (Occultism or Theology 11+, Bard 12+; Clerical Investment), $2,000 + ($1,000 × Reputation bonus)	Worst PR	-1i/-1i, LJ, defrocked
Research Scientist (Any science skill 13+, Research 13+), $5,000	Best PR	3i/LJ, 2d
Slinky Star (Erotic Art or Sensie Interface 10+; upslink implant), $500 × (Best PR-5 + reaction bonus)	Best PR	-3i/LJ, 1d
Terraformer (Two of Chemistry, Ecology, Geology, or Planetology 12+), $400 × Best PR	Worst PR	-2i/-3i, 3d
3D Printshop Manager (Electronics Operation 10+, Merchant 12+), $5,500	Best PR	-2i/-4i, LJ
Wealthy Jobs		
Crime Boss* (Administration 14+, Streetwise 14+), $15,000	Worst PR	-4i/-6i, arrested, 5d
Ghost Writer (Brain Hacking 13+), $12,500	PR	-3i/-7i, LJ, lose license
Nanotechnologist (Engineering (Nanotechnology) 15+), $12,000	PR	-1i/-3i, LJ
Politician (Bard 12+, Politics 15+; Charisma, Status 2+), $14,000	Worst PR	-1i/-3i, LJ, -1 Status
Senior Executive (Administration 13+, Leadership 12+; Status 3+), $13,000	Worst PR	-4i/-5i, LJ
Wetsurgeon or Headslinker (Psychology 14+, Memetics or Surgery 14+), $1,000 × Worst PR-2	Worst PR	-3i/-7i, LJ, lose license
Xoxnapper* (Two of Brain Hacking, Electronics Operation, or Shadowing 12+), $13,000	Best PR-4	-3i, 2d/8d, arrested

* *Freelance:* +/-10% per point the skill roll is made/missed by. Critical success triples income; critical failure means *zero* income.

5

TECHNOLOGY



WHAT'S THE TECH LEVEL?

Transhuman Space is a late-TL9 setting with TL10 biotechnology, but it uses the redefined tech levels from Sean Punch's "TL8 – Then And Now" article in *Pyramid* Magazine. This recasts TL7-9 as follows:

7. Modern (1951-2000): Computer, laser, miniaturization, mature fission technology.

8. Microscience (2001-2050): AI, gengineering, longevity, micromachines, early fusion technology, mobile robots, laser rockets, and vehicle-mounted laser weapons. These technologies gradually appear in early TL8 (2001-2025), maturing by late TL8 (2026-2050).

9. Nanoscience (2051-2100): Environmental engineering, nanomachines, sapient AI, mature fusion technology, early antimatter technology, personal laser weapons, spacecraft particle beams.

As a result of this redefinition, certain technologies are more advanced than in other TL9 ***GURPS*** settings, while others are retarded. ***GURPS Ultra-Tech 2*** provides guidelines for such redefinition, called *technology paths.* In these terms, ***Transhuman Space*** follows the "cyberpunk," "hard science," and "high biotech" paths. If a GM wishes to add items from ***Ultra-Tech*** and ***Ultra-Tech 2*** to the setting, then he should use the guidelines in ***Ultra-Tech 2*** *for that combination of paths.*

Casey woke up on her bed and stretched. Main shift. Her rug tried to cuddle up – she'd left the thermostat down.

"Closet," she told it, "now." It shook itself, then slithered away.

The video wall on the ceiling came to life, emitting a soft light. "Time to wake up, Casey," said her virtual interface. The infomorph was sitting beside the bed, controlling the video wall. "You have lots and lots of mail!"

"Don't be so cheerful," Casey said. She'd taken a Deep Sleep pill the night before, and now she felt disgustingly awake and sober.

"Very well. Ignoring spam, the new season of ***Xoxhunter*** *started last night – I recorded the first episode. The Royal Navy SDV* ***Resolution*** *is in port, and Captain Ironside would like to meet you for brunch. Also, the surveillance dust you left at Mr. Zhang's office wants to talk to you."*

"Okay. Tell it to keep track of who comes and goes. I'll head to the docks." Casey hadn't bothered getting undressed last night. There wasn't time today. She whistled, and her hive opened. A flock of ***Staub Buster*** *aerostat microbots went to work. It tickled. A few moments later, she was clean, and so were her clothes. "Clothes," Casey muttered.*

"Clothes," her infomorph free-associated. "Casey, in three days you have to leave for the party at the Chinese embassy on Ceres. You told Mr. Cohen 11 days ago that you'd need an expense allowance for a new outfit. He agreed. If you're busy, shall I select one for you?"

"Thanks." Casey considered. She had some time before the dockyard bars opened. Might as well shop first. "You're too conservative. Open the Huygens City Mall." Casey slipped on a fitting leotard. Biometric sensors measured her size and uploaded the data. The Huygens City virtual mall appeared around her. She selected the ***Thanh Thao*** *boutique.*

Clothes materialized around her virtual image. An annoying store clerk flitted about her, a virtual butterfly.

"Where will you be wearing, ma'am?" it asked.

"Microgravity," Casey said. "Ceres, actually. I'll get there next month."

"Ah. Then I'd suggest the chyrsanthemum-and-bats print satin top and the dress shorts."

Casey looked at herself. "Shorts in moss green," she suggested. "I'll take the dress in varicloth memswear and the tights in spidergoat arachnoweave."

"May I make another suggestion, ma'am? Hats should be fashionable on Ceres next month."

"Okay, show me what's new." An image appeared. "Ooh, I like that."

"It is an Avatar Klusterkorp skullcat," said the butterfly. "It is self-maintaining, sweat-eating, and has an aphrodisiac purr. Little claws hold it onto your head."

"Yum. Will it try and eat my rug? I've a Euphrates."

"Of course not." The butterfly sounded slightly offended. "It will take two hours to cut; we will unfreeze the skullcat. Do you wish one or several?"

"One." Casey settled on Solar Express for delivery. Credit transferred across an encrypted link. Now, it was time to check that dust trace . . .

This chapter presents a range of equipment available in ***Transhuman Space,*** from computers to microbots.

ENERGY CELLS

Equipment runs on advanced rechargeable batteries. One pound of batteries stores 1 kilowatt-hour (3,600 kilowatt-seconds or kJ) of energy, costs $30, and occupies 0.02 cubic feet. Some standardized energy cells:

AA cell: Costs $0.015; weighs 0.0005 lb. Stores 0.0005 kWh.

A cell: Costs $0.15; weighs 0.005 lb. Stores 0.005 kWh.

B cell: Costs $1.5; weighs 0.05 lb. Stores 0.05 kWh.

C cell: Costs $15; weighs 0.5 lb. Stores 0.5 kWh.

D cell: Costs $150; weighs 5 lbs. Stores 5 kWh.

E cell: Costs $600; weighs 20 lbs. Stores 20 kWh.

Duration: Power requirements for devices are noted with the size and number of cells, and the duration. Thus, "2C (1 hour)" means two C cells provide enough energy for one hour of operation.

Power Drain: Standard batteries are designed to release their energy gradually; i.e., they cannot discharge all of their energy at once. The maximum power output is 4 kW per kWh of storage, which drains the cell in 15 minutes. Thus, a C cell could provide a continuous 2 kW of power, a B cell 0.2 kW, and so on. This is sufficient for most applications, but beam and electromagnetic weapons (for example) require higher power outputs. To handle this, *power packs* are used (see below).

Nonrechargeable Cells: These store twice the energy of standard batteries for the same cost, but cannot be recharged.

Power Packs: These cells use carbon nanotube flywheels or high-temperature superconductors to store energy. They store only 10% the energy of standard batteries for the same cost, but their power output is 3,600 kW per kWh; i.e., they can discharge all of their energy in one second. All power packs are rechargeable.

COMPUTERS

Computer technology uses optical systems with molecular memories and processors; see *Data Requirements* (p. 143). Processing power is rated abstractly in terms of Complexity, with each level representing a roughly tenfold increase in overall capability over the previous level. A system's Complexity determines what programs it can run, and how many; e.g., a program of Complexity 2 can run on a computer system of Complexity 2 or above, but not on a Complexity 1 system.

The number of programs that can run simultaneously is calculated as follows: a computer can run two programs of its own Complexity level, 20 programs of one Complexity level less, 200 programs of two Complexity levels less, and so on. For instance, a Complexity 2 computer can run two Complexity 2 programs, or 20 Complexity 1 programs, or one Complexity 2 program and 10 Complexity 1 programs.

Computers are also rated for their data-storage capacity in terabytes (TB). One TB is roughly 1,000 gigabytes (GB) or 1 million megabytes (MB); see *Databases* (p. 143).

All computers are assumed to have voice-instruction capability. Computer Programming rolls are not required for most purposes; Computer Operation rolls are made at +3.

Being optical, all computers are immune to electromagnetic pulse.

HARDWARE

The table below shows standard computers. These are "serious" hardware; cheaper dedicated computers are integrated into practically everything.

Computer Table

Computer	*Weight*	*Cost*	*Complexity*	*Storage*	*LC*
Macroframe	1,000	$250,000	9	1,000,000	4
Mainframe	100	$50,000	8	100,000	5
Microframe	10	$10,000	7	10,000	6
Small	1	$2,000	6	1,000	6
Tiny	0.1	$400	5	100	6
Options					
Cheap	×1	×0.05	-1	×0.1	+1
Compact	×0.5	×2	–	×1	–
Genius	×1	×20	+1	×10	-1
High-Capacity	×1	×1.5	–	×1.5	–
Printed	×1	×4	–	×1	–
Quantum	×2	×10	–	×1	-1

Cheap computers use inexpensive processors and storage media. They can also be older systems. Quantum computers cannot be cheap.

Compact computers are smaller but more costly.

Genius computers are on the cutting edge of processor and data-storage design.

High-Capacity computers can run 50% more programs simultaneously (three programs of their own Complexity, and so forth).

Printed computers are printed on a flexible surface, such as fabric (so they can be rolled up) or an area of skin (resembling a tattoo). They require 4 square feet per pound of weight. The surface is a solar cell and can power the computer in any environment brightly lit enough not to incur darkness penalties. Breaking the surface destroys the computer. Not compatible with quantum or cybershell computers.

Quantum computers drastically reduce the time required to perform certain processes. Only macroframes can be quantum computers.

Options can only be taken once each. All multipliers are cumulative; e.g., a cheap, high-capacity, tiny computer would cost $400 × 0.05 × 1.5, or $30. Legality Class (see p. B249) modifiers are additive; however, LC cannot exceed 6.

Data Storage: Additional built-in data storage can be purchased for $1 and 0.001 lb. per additional TB, usually in multiples of 10 TB. Double the weight and halve the cost for a cheap computer.

Media

Portable data-storage units are *teradisks* (TDs). Each holds 10 TB and is the size of a sugar cube. $5, 0.01 lb. Old *holodisks* are still used on cheap machines (new systems can also run them); each holds 1 TB. $1, 0.01 lb.

WEARABLE VIRTUAL INTERFACES

These are as common as wristwatches once were. They provide augmented reality (p. 62) and often host AIs.

Virtual Interface Glasses (VIG)

A pair of video glasses with holographic head-up displays in the lenses. Installed in the frame are a tiny computer (p. 141), digital camera, short-range radio communicator (p. 148), infrared remote and receiver (10-yard range), and bone-induction speaker. It has a global positioning unit that automatically queries any accessible navigational satellites or other markers, enabling the user to know his position to within a few yards. It displays information from microcommunicator-equipped electronic systems (which includes just about everything) in front of the user's eyes; this head-up display gives +1 to Piloting, Driving, and other skills that benefit from fast, hands-free display of information. Dedicated Augmented Reality software is included, so the primary computer need not run this program. It is a cybershell, and can house an AI or other digital mind. See *Wearable Virtual Interface* (p. 125).

VIG Frame: The VIG without the computer. Add a tiny computer with any desired options. $500, 0.15 lb., B (10 days).

Distributed Virtual Interface (DVI)

Not everyone wants to wear glasses. A DVI is a contact-lens monocular, a digital camera in a hair clip, an earplug speaker, and a belt-, wrist-, or shoe-mounted mounted tiny or compact small computer. All communicate with one another using microcommunicators. A DVI is more discreet but less convenient than a VIG, taking a few seconds to take off or put on, but otherwise identical except for weight: 0.2 lb. (+ computer).

Implant Virtual Interface (IVI)

See *Brain Implants* (pp. 64-65).

Cybershells and Bioshells

A cybershell or bioshell has the equivalent of an implant virtual interface built into it.

SOFTWARE

Due to the high processing power available, most software is designed to work in concert with AI agents. Thus, instead of a specific "piloting" or "translation" program, one simply acquires an AI as the operating system and then programs or teaches it the relevant skill.

If someone wants to write his own computer program, use the *New Inventions* rules (p. B186; see also pp. CI125-127), using Computer Programming instead of Engineer, with a skill penalty equal to twice the Complexity of the program rather than -15.

AI Software

These artificial intelligence operating systems incorporate language recognition, accommodation learning, data links, and verbal and optical recognition. See *Digital Mind Templates* (pp. 119-120) for capabilities, costs, and Complexity ratings.

A trained AI costs more: $100 per character point of advantages or skills beyond its model templates, and $800 (NAI), $6,000 (LAI), or $30,000 (SAI) per added character point spent on DX and IQ. In areas where SAIs are citizens, they cannot be bought and sold – a creator has the same responsibilities as does a parent to his child.

A copy of a second-hand or black-market AI is cheaper, but may have picked up various bad habits. Simulate this by giving them a few points of quirks and disadvantages, and by not charging for any advantages or skills acquired through these extra points. However, an NAI will not usually have more than -15 points, an LAI more than -25 points, and an SAI more than -45 points of bad habits. Suitable disadvantages for NAIs and LAIs include Bloodlust, Combat Paralysis, Cowardice, Gullibility, Impulsiveness, and Truthfulness. An SAI could have any mental disadvantage not inappropriate to its physical form.

Shadows: A shadow costs about as much as an equivalent ordinary AI. Creating a custom-made shadow adds a further $10,000 for deep brainscanning. Note that any number of shadows can be created using the data from a single deep brainscan. A copy of an existing shadow may cost the same as a skilled or second-hand AI (depending on the situation). A shadow of a celebrity often costs an extra 10% per point of positive Reputation or Status he had.

Ghosts: Ghosts are usually only available on the black market, since they are considered sapient in most places. Cost varies dramatically, depending on the individual. A rare xox of a celebrity may sell for several *million* dollars. Note that a ghost can be used in lieu of a brainscan to create shadows.

Augmented Reality and Cosmetic Software

Augmented Reality: The basic program used to work with a virtual interface and govern machine-human communications. It is normally a dedicated program, but if bought independently, it is Complexity 4, $100.

Mugshot: This program identifies faces in real time, matches them with biographical data, and assembles an appropriate précis. Effectiveness depends on whether the subject is likely to be in the user's databases or on the Web. Complexity 4, $100.

Social Telepresence: Two (or more) people with virtual interfaces can initiate a social telepresence conference provided each has a copy of this program. The interfaces relay imagery of their surroundings plus the chosen avatars of the users; the interfaces also track body movements. The result is the illusion that the person talking to you is next to you. Includes the ability to load graphic images into the "avatar" file (this can also be a direct feed from a camera, if desired). Complexity 3, $100 for 2D; Complexity 4, $200 for 3D.

Virtual Tutor: This coaches the user in a specific task, such as building a house. User has an effective skill of 12 for an Easy skill, 11 for an Average skill, 10 for a Hard skill, or 9 for a Very Hard skill. Any necessary parts must be purchased with appropriate v-tags. Typically Complexity 3, $100.

Databases

A database is a collection of information in computer-readable form. All databases have built-in search and indexing programs. For a database of a given size, the wider the subject it covers, the less detail it has. Database size is measured in gigabytes (GB) or terabytes (TB).

Information

Information costs are highly variable: an encyclopedia or similar item might be free for download, or cost from $1 to $100. Cost does not necessarily correlate directly with size, but rather with copyright, supply, and demand.

3D Blueprints: The instructions to build a gadget using a 3D printer or robofac. Legal 3D printer software for many commercial goods is subject to licensing agreements that require royalty payments based on the quantity of goods produced, typically 10%-50% of the base cost of the item. The royalty may exceed 90% on goods whose main cost is their artistic value, information content, or trademark (e.g., designer clothes). Complexity 4, 0.1 GB for devices costing up to $100, Complexity 5 and 1 GB for devices up to $1,000, etc. LC is equal to that of the item.

InVid: "Interactive Video" is the mass media of 2100, although it's being supplanted by newer technologies such as slinkies. It refers to audiovisual programs that react to the user's expressed mood and preferences using both built-in AI and the ability to access the Web for additional information. An InVid might be as simple as a sports program that allows the user to switch viewpoints between players and offers stats on demand, or as complex as a multi-path drama that analyzes the user's mood and responds to it. InVids also include old-style computer games. To run any kind of InVid, a computer needs a virtual interface or a video wall. InVid rentals are 10% of purchase price.

DATA REQUIREMENTS

Programs:
- Complexity 1: 0.01 GB.
- Complexity 2: 0.1 GB.
- Complexity 3: 1 GB.
- Complexity 4: 10 GB.
- Complexity 5: 100 GB.
- Complexity 6: 1 TB.
- Complexity 7: 10 TB.
- Complexity 8: 100 TB.
- Complexity 9: 1000 TB.

Slinky recording, 1 second immersion: 0.1 GB.
Slinky recording, 1 minute surface: 0.1 GB.
20 min. video or 40 min. high-res graphics: 1 GB.
1,000 hours low-fi, 20 hours medium-fidelity, or 2 hours hi-fi audio: 1 GB.
50,000 low-res graphics: 1 GB.
Complete street-level map of large country: 1 GB.
Lifelike virtual avatar character: 1 GB.
Plans of 100 small or 10 complex vehicles: 1 GB.
Genetic map of one human: 2 GB.
Lifelike virtual outdoors, per square mile: 5 GB.
Detailed global navigation charts: 0.1 TB.
Lifelike virtual house or park: 0.1 TB.
Public or school library: 0.1 TB.
City or college library: 1 TB.
Lifelike virtual mansion: 1 TB.
Big city or university library: 10 TB.
Lifelike virtual street or mall: 10 TB.
Shadow mind emulation: 10 TB.
Large university or copyright library: 100 TB.
Ghost mind emulation: 100 TB.
Lifelike virtual neighborhood: 100 TB.
Lifelike virtual city: 100 TB per 1,000 population.
Less-realistic "magic realism" VR takes up 10% of space; cartoon VR takes up 1%.

InVid (software): Complexity 3-5, $10-$100, 0.1-1 TB.

Slinky Media: May be expensive, or free with a data subscription, if accessed over the Web. New entertainment slinkies are typically $10 per GB.

Mind-Emulation Software

Ghost Compiler: Required to allow someone with Artificial Intelligence skill to create a ghost. Complexity 9, $12,800. LC 2.

Shadow Compiler: As above, but used to create a shadow. Complexity 7, $6,400. LC 2.

Ghost-Editor Program: Allows someone to use Brain Hacking skill on a mind emulation; see *Brain Hacking* (p. 136). Complexity 8, $20,000. LC 0.

Robotics Control Software

Swarm Controller: Lets a user command and control microbot swarms through a virtual interface. The GM can make a secret Electronics Operation (Robots) skill roll to see if the swarm understands the orders (apply penalties for confusing instructions). Failure means the swarm does not do quite what was intended (GM's option). A separate program is needed for each swarm type. Complexity 4, $200. LC is equal to that of the swarm it controls.

Teleoperation (Direct Control): Allows someone with a virtual interface implant to teleoperate a cybershell (see box). Both the controller and the cybershell need this software. Complexity 4, $5,000. LC 5.

Teleoperation (VR Control): As above, but usable with a nonimplant virtual interface. The user needs VR gloves if he wishes to experience touch through the cybershell; if he wishes to experience other tactile sensations (if possible through that shell), he needs a VR Suit (p. 149). Both the controller and the cybershell need this software. Complexity 4, $2,500. LC 5.

Skill Sets

These knowledge bases give an AI a particular "prepackaged" skill. The AI may use the skill directly (if it occupies or teleoperates an appropriate cybershell) or, if it lacks necessary body parts, in virtual reality. Skill Set software is disconnected from the AI's own set of learned skills; the skills only apply when the AI is running the program, and are not cumulative with learned skills.

TELEOPERATION

Teleoperation is the remote control of a cybershell, generally via a radio, infrared, or laser communicator. The teleoperator and cybershell both require teleoperation programs. The cybershell's program normally requires a password, limiting access to authorized teleoperators.

The teleoperator uses the remote-operated ("drone") cybershell's sensors and controls it, superceding the drone's own digital mind, if any. The drone is effectively unconscious while being controlled. For ST, DX, or HT rolls, use the drone's values. The controller uses his own IQ, Will, and skills. However, in the case of DX- or HT-based skills, modify by the difference in DX or HT values; e.g., a teleoperator with DX 14 controlling a DX 12 drone would have a -2 penalty on DX-based skills. The GM determines which advantages and disadvantages are applicable. In general, the teleoperator uses those drone's physical advantages or disadvantages, but his own mental ones.

There is also a "telepresence penalty" on anything done through the drone. It varies by software: -1 if using direct control, -2 if VR control. Teleoperation also assumes the teleoperator is focusing entirely on the drone and not doing anything else. Otherwise, there's a -4 penalty on anything he's doing either with the drone or with his real body.

A teleoperator can control multiple drones. Apply a cumulative -2 per drone after the first to all rolls to operate any of the drones. Each drone also needs an extra program.

The speed of light is an issue for long-range teleoperation. Every 186,000 miles (1 light-second) between the operator and the cybershell imposes a one-second delay on any action. Even split-second light-lag can be a problem: a teleoperation action such as dodging or shooting at a moving target is at -1 per 10,000 miles.

Teleoperation requires a two-way communications link. If this is jammed or interrupted, the teleoperator loses control.

TOP 10 AI COMPANION SKILL SETS

Accounting-11: Used to manage personal finances.

Cooking-13: Used to prepare gourmet feasts at home.

Diagnosis-11: Used to track biomonitor input and provide health advice.

Driving (Automobile)-11: Used to control an auto.

Electronics Operation (Communications)-12: Used to manage satellite TV reception and basic communications security.

Erotic Art-10: Used to control an avatar body in virtual reality.

Games-13: Each game type is a separate skill.

Language-12: Used for real-time translation.

Research-12: Used for online data mining. Often bought with an optional specialty; e.g., current events, people's faces, bargains, or porn.

Writing-12: Used to turn spoken words into text; called a "voice processor."

All of the above are Complexity 3, $50.

Skill Set Table

Complexity:	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Cost:	$50	$100	$200	$500	$1,000	$2,000	$5,000
Skill Level:							
M/E	13	14	15	16	17	18	19
M/A or P/E	12	13	14	15	16	17	18
M/H or P/A	11	12	13	14	15	16	17
M/VH or P/H	10	11	12	13	14	15	16

Note: Skills sets are -3 in nonroutine situations, like combat or emergencies. A cybershell's DX bonus adds to DX-based skills. Artificial Intelligence, Computer Hacking, Combat/Weapon, and Thief/Spy skills are Legality Class 4.

Tactical Programs

HUD Targeting: Used in conjunction with a HUD sight-equipped missile weapon, by a shooter with a virtual interface (p. 150), this projects crosshairs on the user's field of view, showing exactly where the weapon is pointing. It also allows the user to see around corners. HUD Targeting subtracts 5 from SS number. Complexity 1, $250. LC 5.

TacNet: This software helps a leader monitor a combat force by intelligently tracking and displaying their positions, firing arcs, blind spots, command relationships, etc. It adds +1 to Tactics skill when commanding a unit of the given size or smaller. Complexity 2, $1,000, LC 4 for a squad (or up to 2 vehicles); Complexity 3, $2,000, LC 3 for a platoon (or up to 6 vehicles); Complexity 4, $4,000, LC 2 for a company (or up to 12 vehicles); Complexity 5, $8,000, LC 0 for a battalion (or up to 36 vehicles).

Target Tracking: Used in conjunction with a sensor system such as a radar, radio direction finder, or PESA, it keeps track of 10 distinct targets or emission sources simultaneously, displaying appropriate information (size, signal strength, bearing, vectors, etc.) on a moving-map display. Complexity 2, $100. Add +1 to Complexity and double cost per tenfold increase in targets.

Virtual Reality Programs

Basic VR Program: Allows a virtual interface to track the user's body motion and translate it into virtual reality, obviating the need for a suit unless tactile sensation is to be transmitted, but this is sufficient to walk around and (with the addition of VR gloves) manipulate objects. Complexity 3, $200.

Neural VR Program: Used with an implant virtual interface (p. 150). Gives a deluxe, full-sensorium experience (Complexity 4, $500) or utterly lifelike virtual reality (Complexity 5, $4,000) with no need for suits, etc.

VR Database: A packaged virtual environment, character avatar, etc. $1 per GB or $1,000 per TB for off-the-shelf versions, 10 times that (minimum $20) for a custom design. See *Databases* (p. 143). Use with VR Manager.

VR Manager: Supports 10 users per program in total VR. Complexity 5, $500. Add +1 to Complexity and double cost per tenfold increase in users.

CONSUMER GOODS

These items are what most people spend their money on.

CLOTHING

Base costs for new clothing: $50 for a set of casual clothes, $250 for a formal outfit. Double cost for top brand names and quadruple cost for designer fashions, but halve cost for pirated designs or used clothing. Also double cost for winter wear and halve cost for light summer wear. Normal clothes weigh 1 lb.; winter clothes weigh 3 lbs.

CHILDPROOF BIOMETRICS

This technology is an evolution of the trigger locks on guns. Paint-on biometric scanners may be integrated into medicine bottles, cookie boxes, adult InVid, beer cans, etc. When someone buys (for example) a can of beer, the act of electronic purchasing uploads his thumbprint signature (and that of his partner, if desired) onto the can's seal. Now only he can open it. Some countries require this sort of thing for many products, while others make it optional.

Smart Fabrics

These incorporate microelectromechanical systems (circuits, sensors, or motors) woven into the fabric, allowing them to alter their shape, texture, or color. Solar cells or static-electricity collectors provide power. These options can also be applied to flexible armor suits (p. 159). If adding percentage costs to armor or clothing costing over $1,000, calculate the additional cost as if the clothing cost only $1,000.

Buzzwear: Clothes (or other fabrics, such as carpets, sheets, or upholstery) with microscopic motorized brushes that repel dirt and grime. It also sheds water much more rapidly than usual, and can dry in one-fifth of the normal time, making it popular rainwear. Despite its nickname, it is inaudible. +100% to clothing or fabric cost.

Memswear: This is clothing (including footwear and imitation-leather goods) that automatically tightens or loosens to give a better fit. Microscopic sensors and motors in the fabric adjust it as needed. It is by no means one-size-fits-all apparel, but it offers more tolerance than "dumb" clothing and is *very* common in footwear. It can also change porosity, to adjust to changes in temperature and humidity. +200% to clothing cost; halves the weight of winter clothes.

Varicloth: Fabric can have imprinted electronic circuits that allow it to alter its color. A sweater, dress, jacket, shirt, pair of pants, or skirt may be bought with many color patterns programmed into it; one can switch to the next pattern by running a finger over a sensor concealed in the garment. Appropriate camouflage gives a -2 on any roll to spot the user. +200% to clothing cost.

Videocloth: Clothing that acts as a video display. +100% to clothing cost.

The above options can be combined; percentage modifications are additive.

Avatar Outfits: People often meet via telepresence. An off-the-shelf avatar outfit is free with the software, but a brand-name digital fashion (for humans or infomorphs) is $20, and a custom-designed outfit may be $200+.

OTHER HEALTH AND FASHION ITEMS

Diamond Nanogel: Allows bite to do thrust-2 cutting damage if human. First developed for guard dogs (+1 damage if they already have Sharp Teeth). Lasts 1 year. $1,000.

Digital Hair: Smart electrostatic shampoo allows hair to bind as a flexible video display and antennae, displaying programs in virtual interface. Breaks down after a week. $100.

Nanogel Toothpaste: Paint on teeth for long-term protection against cavities. Lasts about a year. $100.

*Nanomorphic Tattoos:*Tattooing with nanoprocessor ink is the latest fad. These are vivid tattoos that can follow preprogrammed scripts in response to changes its microsensors detect in the skin (sweat, temperature, etc.). For example, a tiger that roars when skin sensors detect anger . . . or purrs when the wearer is aroused. $500 per tattoo, plus $250 per extra function.

Skullcat: A living hat. Keeps the head warm, solar-powered, and its aphrodisiac purrs add +1 to Sex Appeal for people who like cats, but drive others nuts. $500. Numerous other biotoys exist.

Suitspray: Skintight nanopore equivalent to light clothing. Peels off under sonic shower. $4, 0.25 lb.

FURNISHINGS AND DOMESTIC EQUIPMENT

2D Video Wall: A video display and speaker that uses low-wattage nanocircuits. The wall itself ripples to generate sound, allowing a huge directional speaker effect if desired. Most residences have these; they are also used for ad walls, etc. $10 and 0.05 lb. per square foot.

TOP SIX FUN FOODS AS OF JANUARY 1, 2100

1. *Nanopaste Rations.* New from SpaTek! Originally developed for the USAF. Fun for kids! Programmable. One tube has 100 great flavors and textures! $10, 0.5 lb. per tube.

2. *Alibanana.* The new biofruit from Biotech Euphrates, combining two great tastes: alligator and banana. Peel off the scaly hide and bite down for scrumptious goodness! Serve with milk. $0.50.

3. *Dali Koke, the Surreal Thing.* A nootropic drink containing bioengineered proteins that affect the brain, triggering especially weird dreams. $5 per drink.

4. *Mars Spidermilk Chocolate.* From genuine Martian spidergoats. "Low-G means low fat!" $1 on Mars, $2 elsewhere.

5. *Safeburger.* The latest in smart fauxbeef. Eat it as fast as you like, you'll never choke. $2.

6. *Captain Mnemo:* Smart drug candy that extends and amplifies short-term memory. Taking it strengthens memories formed while the drug is working, so that they can be recalled with superior clarity later (+3 on IQ rolls to remember). Lasts 10 minutes. $5.

3D Video Wall: A phased-array screen and speaker system that can function as a high-res 3D audiovisual display, producing imagery indistinguishable from reality. $50, 0.05 lb. per square foot.

Diagnostic Toilet: A biosensor unit built into the toilet scans the user's wastes, and a microcommunicator updates his virtual interface if anything odd is detected. Diagnostic toilets routinely determine if someone has diseases, poisoning, parasites, or other problems. Public diagnostic toilets may alert health authorities if they detect contaminants such as infectious diseases or nanoviruses. $200.

Domestic Nanocleanser: A solution of microscopic cleaning bacteria that work to remove stains, grime, dirt, dandruff, loose skin flakes, etc. from surfaces (organic or inorganic). It can serve as a shampoo, soap, or detergent. It can also remove forensic evidence such as bloodstains or skin flakes. Treating an area imposes a -3 penalty on any rolls made to locate or analyze such evidence. However, forensic microbots (p. 170) can identify the exact brand of nanocleanser used! A can ($25, 0.5 lb.) lasts for 2 weeks of routine domestic cleaning or one big job.

Fitting Leotard: Scans body to determine measurements for uploading to clothing shops. $200, 2 lbs.

Smart Rug or Bathmat: This slowly tugs itself across the floor, slurping up dirt, puddles, deposits of soap and hair spray, hairs, etc. ST 4, DX 4, IQ 1, HT 12/8; Move 1. $500.

Sonic Shower Head: A luxury item that can be a necessity in water-poor areas or spacecraft. An ultrasonic spray clipped to a wall simultaneously cleans and massages the user. $800, 20 lbs.

Wombskin Bed: It's alive, warm, and you'll never want to leave. $7,500, 20 lbs.

COMMUNICATIONS AND INFORMATION EQUIPMENT

Most people and machines are constantly tied into a system-wide flow of information via radio, cable, and even laser communication links.

DATA NETWORKS

Computers connected to a communicator can access local or system-wide networks through their communications service provider, once an account is established; the largest provider is Teralogos. Most use a mix of satellite transmission, optic cable, and local relay stations. The cost of subscribing varies with the speed and quality of service, but $10/month is usual, with additional charges for storing extra data online ($1/TB/month).

FOOD AND ACCOMMODATIONS

Apartment: $400/month.
Groceries, 1 week's supply: $50.
Hotel, good: $200/night.
House, 4-bedroom: $100,000.
Motel, cheap: $50/night.

Prices are global averages. Multiply by 5 in areas where average wealth level is Wealthy, by 2 where Comfortable, by 0.5 where Struggling, and by 0.2 where Poor.

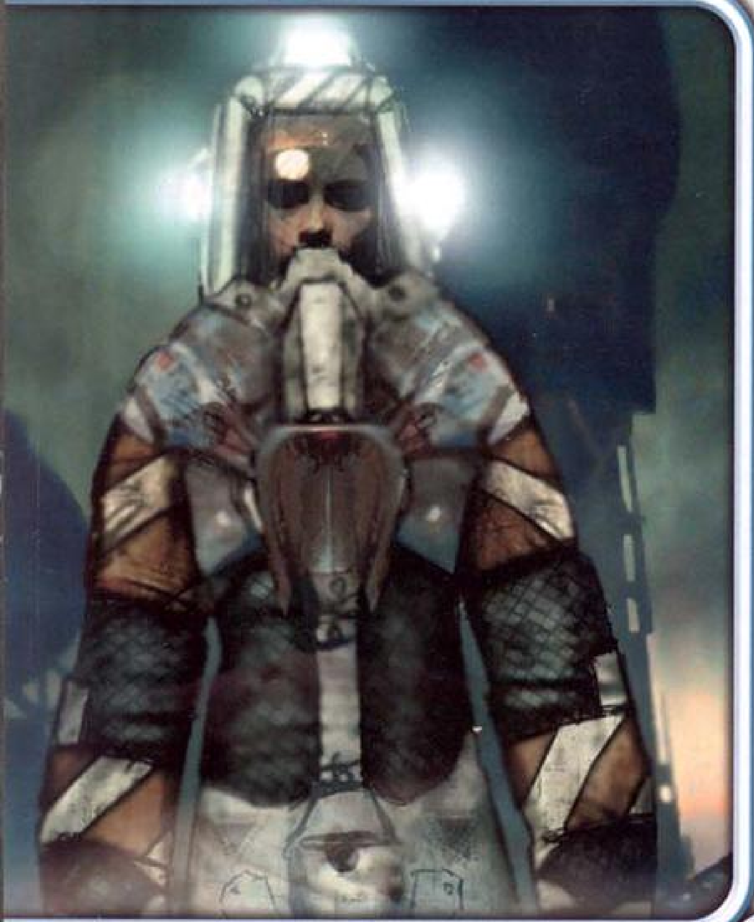
Food and accommodations are included in the monthly cost of living (see p. 128).

Data Security: Commercial providers do not monitor data content – in most countries. Some local laws require this, and restrict available encryption protocols. However, all service providers can monitor the *flow* of data, which can provide valuable information to investigators.

Data Transfer Rates: 1,000 GB/second for optical cable (most buildings have these), 1,000 GB/minute for laser, 10 GB/minute for infrared or microwave tightbeam transmissions, and 0.1 GB/minute for radio.

Data Havens: Data havens are service providers established in locations where governments have promised not to monitor data flow, or in areas which lack governments. They charge an average of $50/month for services and $10/TB/month for data storage. They promise not to provide this information to others. It comes down to whether you trust them more than governments – one scandal can destroy a data haven's reputation.

WebCom: Anyone registered with a com service provider can use a radio communicator as a cellular audiovisual phone. This costs an additional $10/month per individual com number added to the subscription. Long-distance calls on the same celestial body are free, while interplanetary calls may be placed for $10/AU/minute (minimum $1/minute).



Encryption

All messages, electronic mail, and signals are routinely encrypted using strong encryption protocols, unless deliberately sent in clear. No special com scramblers are required.

Nearly all encryption uses a public-key system. In conventional encryption schemes, keys must be exchanged by some other secure method; this is often difficult, since (presumably) a lack of secure channels is why the message is being encrypted in the first place. In public-key encryption, the encryption and decryption keys are different. Therefore, the encryption ("public") key can be made public knowledge (part of one's e-mail, often included as a "signature") and used by any would-be sender to encrypt a message to its owner. This message cannot be decrypted with the encryption key, so no one other than the intended recipient can decrypt it – *including* the sender who encrypted it. When someone receives a message encrypted with his public key, he uses his secret ("private") decryption key (stored, encrypted, on his computer) to decrypt the message.

Cracking 2100-era encryption is effectively *impossible* using normal means, as normal keys are designed to take a century or more to crack using the best arrays of computers running at full speed. They *can* be cracked using quantum computers (p. 66), but not in real time, as it generally takes a single Complexity 10 quantum computer about a year to crack the encryption on a message.

Quantum Encryption: This is the ultimate form of encryption. It is only possible for direct lasercom or fiber-optic transmissions – not for conventional radio or net. Eavesdropping on a quantum-encrypted message alerts the sender and recipient. A laser communicator can be modified to use quantum encryption for $5,000.

COMMUNICATORS

If the user has a com subscription, then he can use a communicator as a cellular webcom and (if there's a relay station in range) reach anywhere in the solar system. All communicators can link to a virtual interface, providing video even if the com system does not have its own screen.

Radios

These are broadcast radios: everyone within range can detect the signal, although transmissions are normally sent as encrypted data. Effective range can be increased by up to 100% with an Electronics Operation (Communications) roll, at -1 per extra 10%. (One try per minute.) Not usable underwater.

Implant Communicator: A surgically implanted model with 1-mile range. $250 (plus $500 and 1/2 hour for the surgery).

Short-Range Communicator: An earplug-sized model with 12.5-mile range. $25, 0.125 lb., A (8 hours).

Medium-Range Communicator: A palm-sized model with 25-mile range. Includes video screen. $100, 0.5 lb., B (8 hours).

Long-Range Communicator: A backpack-sized model with 50-mile range. Includes video screen. $300, 5 lbs., C (8 hours).

Microcommunicators: These are too tiny for humans to use directly, but are built into most electronics and many other devices, enabling augmented reality and interconnectivity. Each is about 1/100" across, with negligible weight and cost ($1 per 100). Range is 1 yard. They draw a miniscule amount of power from the system they're built into.

Radio Direction Finder (RDF)

This device can detect the approximate direction and distance (via signal strength) of a particular radio transmission. Transmissions are routinely encrypted, and in busy areas (such as a major city) there may be hundreds of thousands to sort through, all of which are very difficult to tell apart (but see *Target Tracking* program, p. 145). Thus, the user should specify narrow parameters; e.g., telling the RDF to hunt for "nearest unidentified transmitter" will let you track that teleoperated cybershell that's sneaking through your building, via the telemetry it transmits back to its operator. RDF range is the *lower* of its own range or the transmitter's (tiny microcommunicators can't usually be tracked). Two or more separated RDFs (say, 100 yards apart) can be used for precise triangulation to fix locations. The GM may require an Electronics Operation (Communications) roll to isolate a particular signal to allow it to be tracked. Treat as radio communicators, but at 5 times cost.

Infrared Communicator

Uses a narrow beam of infrared radiation receivable by another IR communicator or receiver. 50-yard range. Not usable underwater. $130, 0.25 lb.

Laser Communicators

Use modulated laser beams to transmit data, audio, or video. The signal is receivable only by another lasercom in the direct path of the beam, although it can be relayed through multiple communicators (including satellites). Intervening objects or terrain, smoke, bad weather, and murky water can block the signal. Multiply given range by 10 in trace atmospheres or vacuum; divide by 10 in clear water.

Short-Range Lasercom: 20-mile range. $312, 1.3 lbs., B (8 hours).

Medium-Range Lasercom: 200-mile range. $1,000, 5.5 lbs., C (8 hours).

Long-Range Lasercom: 2,000-mile range. $3,750, 55 lbs., D (8 hours).

VIRTUAL-REALITY GEAR

VR Gloves: Allow manipulation of objects and transmission of tactile sensation in VR. $500, 0.25 lb. Can be incorporated into clothing or armor.

Deluxe VR Suit: Blocks out the "real world" and can transmit sensation to any area of the body. Use with any virtual interface. $5,000, 16 lbs.

Sensor Gloves: These are equipped with nanomechanical tactile, pressure, chemical, and biometric sensors. They can weigh items by lifting them, measure the hardness and smoothness of materials, detect chemicals, read ink printing, and scan any of this information into computer memory by touch. This gives the equivalent of Sensitive Touch advantage (p. CI65). Using sensor gloves requires a virtual interface. $2,000, 0.2 lb.

IMPLANTS AND INTERNALNETS

Brain implants are surgically inserted in the user's brain and linked to his central nervous system. Insertion is normally safe if performed in a clinical setting, but a quick-and-dirty insertion may require a Surgery roll, with failure damaging or destroying the implant and critical failure causing brain injury (-1 IQ, or a disadvantage such as Epilepsy).

Removing a brain implant is done in the same way as implanting one. However, it is possible to booby-trap an implant, with a cortex bomb that will kill the user and do 1d-1 damage to the surgeon (or his equipment, if operating remotely) if removal fails. If an implant is booby-trapped, then the trap must be removed first (use Traps skill) or it will activate when an attempt is made to remove the implant.

Implants are normally invisible and undetectable without a diagnostic bed or HyMRI. Since brain implants usually require other external devices or have other disadvantages, they do not cost character points.

Virtual Interface Implant (VII)

A virtual interface implant is functionally similar to virtual interface glasses (p. 142), except information is exchanged and displayed through the user's senses and thoughts. The implant translates digital information into electrochemical impulses, and vice versa. A VII is also a cybershell, and can house a digital intelligence (see *Virtual Interface Implant,* p. 125).

This has two main advantages: it allows for a superior teleoperation and virtual-reality experience, and it is convenient. The VII provides no additional skill bonuses. A VII also includes a tiny computer and an implant communicator that allows it to interface with any other implanted or wearable device.

A VII costs $2,000 (plus $2,000 for surgery) *plus* the price of a tiny computer. The computer must be compact, and may have other options (except for printed).

The user will normally control his own VII, but it is possible to implant one operated by a digital mind for which the implantee lacks the command codes.

Distributed VII: This is a small computer, part of which is implanted in the brain and other parts of which are distributed through the user's body. Costs $4,000 (plus $4,000 for surgery) *plus* price of a small compact computer.

Sensory Uplink ("Upslink") Implant

An upslink implant translates the user's sensory perceptions and surface thoughts into digital form. Data is transmitted via microcommunicator at 0.1 GB/second. The user needs a virtual interface (worn or implant) or implant communicator to store or transmit the data.

Standard Upslink: A standard upslink costs $8,000 (plus $2,600 for surgery). LC 5.

Passive Upslink: These upslinks are remotely controlled by someone other than the subject. They are often used to observe animal behavior, monitor prisoners, etc. Same cost, LC 4.

Sensory Downlink ("Downslink") Implant

A downslink allows its user to interpret slink recordings or live upslink transmissions. In either case, the user receives all sensory information that was experienced by the upslink user: feels what he feels, sees through his eyes, and so on.

Upslink data can be experienced in *immersion* or *surface* mode. In immersion mode, the user is unable to use his own senses and is effectively a passive receiver. If the slink recording or transmission includes pain or injury, someone accessing the data also feels pain and suffers shock, knockdown, and stunning, but takes no damage. As well, the downslink user must make Fright Checks if the upslink user did. The GM should also require Fright Checks in the event of severe injury, torture, death, etc. suffered by the upslinker.

In surface mode, the user experiences another's perceptions, but they are slightly muted. He can still function, but he will be distracted (-3 on other activities, unless the task is one that would benefit from intimate knowledge of what the subject is feeling; e.g., attempting to interrogate or seduce him). The user suffers only half the subject's shock penalties, and is at +4 on any HT rolls or Fright Checks required.

A downslink costs $7,000 (plus $1,400 for surgery).

Puppet Implant

This implant can be installed in a person's brain to allow remote control of his body by someone running biopresence ("puppeteer") software. The remote puppeteer controls the subject. The rules under *Teleoperation* (p. 144) apply. There is no additional penalty if the controlling entity also resides in the subject (e.g. a VII taking over its host body), but if he controls a puppet externally using radio rather than a cable jack, bandwidth limitations require the user to deliberately "downgrade" his primary sense (add Color Blindness to vision, reduce Discriminatory Smell to normal smell, etc.).

A puppet implant costs $50,000 for sapient species such as humans or sapient uplifts, $20,000 for presentient animals. It can be implanted in any mouse-sized or larger creature. LC 2 (humans), LC 4 (animals).

Implant Jack

A skull socket. User must have a brain implant; the jack is included at no extra cost. This simply allows the user to plug an optical cable into his head for higher data-transmission rates. Usually used with a VII, but useful for control of puppets, etc.

SENSORS

Optics

These enhance normal vision. Optics are available as goggles or glasses, or built into a wearable virtual interface or helmet.

Anti-Glare: Protects against bright flashes, lasers, etc. as per Polarized Eyes (p. CI63). $37, negligible weight.

Infrared: Gives wearer Infravision (p. CI58). $300, 0.5 lb., B (2 months).

Low-Light: Gives wearer Night Vision (p. B22). $150, negligible weight, A (6 months). This is free with a wearable virtual interface.

Multiview: Standard multisensor imaging system. User can switch between normal vision, Infravision (p. CI58), Night Vision (p. B22), and Polarized Eyes (p. CI63). $600, 0.75 lb., B (1 month).

Teleview: As per multiview, but adds 1-4 levels of Telescopic Vision (p. CI68), usable with any of the options. Add 25% to weight and cost per level.

Search Radar

Searches a 120° arc each turn as per Radar Sense (p. CI63). Most moving targets are detected automatically, but an Electronics Operation (Sensors) roll – possibly opposed by the target's Stealth skill in a Quick Contest – is required to detect a hidden or slow-moving target, or one using countermeasures.

Mini: 2-mile range. 1.5 lbs., $500, 2C (0.5 hour).

Heavy: 10-mile range. 7.5 lbs., $2,500, D (0.5 hour).

Specialized Scanners

Biometric Scanner: Multipurpose identity scanner. Can identify a fingerprint or retina print (1-yard range, if the subject is stationary), voiceprint, or DNA print (requires hair or blood sample), if this data is in a database accessible to it. $1,000, 1 lb., A (1 day). Available in handheld and scanlock versions. Scanlocks are integrated into a lock on a door, case, or other device. Security personnel use handheld units to check identities against databases.

Chemscanner: Uses a laser beam to detect airborne chemicals within 1,000 yards. Good for detecting chemical agents, microbots, nanomachines, or biochemical contamination. Cannot scan through solid objects. Use Chemistry skill to analyze whatever is discovered. $1,000, 2 lbs., C (1 hour).

Chemsniffer: A handheld sensor that can detect drugs or explosives by analyzing traces in the air. It has a range of biosensor chips for 100 standard chemical compounds. Use Electronics Operation (Security Systems) to operate it; the device has a 5-yard range. If its target is sealed in airtight containers, the scan is ineffective. $700, 1 lb., B (1 month). LC 5.

Field Scanner: Detects electrical fields as per Field Sense (p. CI55). Useful for detecting bugs, hidden microbots, or electrical faults. $1,000, 2 lbs., B (1 day).

SURVIVAL GEAR

Here is some representative equipment for campers, soldiers, and anyone living or working in a hostile environment.

EXPEDITION GEAR

Autograpnel: Fires a grappling hook up to 50 yards, and can lift 400 lbs. at 5 yards per second. Rope not included. $200, 3 lbs.

Envirobag: An insulated sleeping bag, good for temperatures down to -10° and up to 100°. An optional heating unit, using a C cell, works as for the thermo suit (see below). Can be sealed and hooked up to air tanks. Folds to the size of a paperback book. $38, 3 lbs. Heating unit is $25, 0.5 lb.

Enviro-Bubble: Emergency inflatable bubble with self-sealing flap that can be entered and inflated within a few seconds (make a DX or Vacc Suit roll). Provides 15 minutes of air. Flexible enough to move around in, but at Move 1. $400, 2.5 lbs.

Filtration Canteen: Purifies one quart of water in 30 minutes. The filters are good for 100 quarts, less if using badly contaminated water. $88, 1.5 lbs. Replacement filters cost $13.

Inertial Compass: Gives +3 to Navigation and Orienteering skill rolls. $125, 0.5 lb., A (1 year).

Nanofiber Rope: Supports 4,000 lbs. $30, 2 lbs. per 10 yards.

Pressure Box: A pressurized container (internal dimensions are 2' × 1' × 1') for carrying fragile items (or pets) through vacuum or hostile environments. It includes connections for air tanks and its own life-support pack. Multiple boxes can be linked to form a larger box. $100, 4 lbs.

Pressure Tent: Includes an airlock and protects occupants from vacuum. Various sizes: 1-man ($500, 15 lbs.), 2-man ($1,500, 30 lbs.), 8-man ($5,000, 150 lbs.).

Rations, Self-Heat: A tasty, self-heating meal-in-a-box. $5, 1 lb.

Rations, Preserved: A meal of canned or packaged foods; shelf life is at least a decade. $2, 0.5 lb.

Vapor Canteen: Draws moisture from the atmosphere as long as there is any water vapor at all. It extracts and holds one quart of water. Time required varies; in 50% humidity, it takes 4 hours to extract a quart. Extracts 50 quarts on a C cell. $450, 2 lbs. empty; 4 lbs. full.

SIX EMERGENT TECHNOLOGIES

People are working on these in laboratories across the system. Secret prototypes may already exist, or breakthroughs could be decades away.

1. *Molecular Nanotechnology.* Research is underway on inorganic robots capable of molecular assembly and disassembly. See *Nanofacs,* pp. UTT21-22.

2. *Solid Metallic Hydrogen.* Attempts to create stable room-temperature superconductors and ultra-high-performance rocket fuel continue.

3. *Neuroviruses.* These are nanomachines that can rewire a victim's brain to alter his personality. See p. BIO79 for details.

4. *Metamorphosis.* This takes proteus virus nanotechnology to a new level, taking apart a living body, reprogramming the cells, and reassembling them into a new form. See *Metamorphosis Virus,* pp. BIO79-84.

5. *Sapient Swarms.* These are microbot swarms whose software is modified so that they can maintain a significantly smarter form of gestalt intelligence. Perhaps a large swarm might form a low-sapient AI, with its own personality. Could a big enough swarm result in an emergent intelligence?

6. *Utility Fog.* These are tiny airborne microbot or large nanobot swarms that can link together to form solid objects (such as furniture) or dissipate like fog. See *Miracle Fog,* pp. UTT22-23.

There's also plenty of more mundane research going on, such as TL11 genemods, better cybershells, faster 3D printers, and smarter AI.

LIFE SUPPORT

Masks, respirators, and so on take 3 seconds to put on, 1 to remove.

Air Mask: A breathing mask with goggles. Attached to an air tank, the user can breathe normally on Mars or at high altitudes on Earth; it also works as a gas mask. $100, 2 lbs. For $50 more, it has an emergency tank with 3 minutes of air.

Air Tanks: 2-hour tank: 2 lbs., $115. 24-hour tank: 7 lbs., $120. Tanks take 10 seconds to put on, 2 to drop. These include rebreathers that capture exhaled CO_2 and water and recycle them. Also available: heated tanks (usable only on Titan); includes C cell (2 hours) or D cell (24 hours).

Artificial Gill: Mask-and-backpack unit allows user to breathe underwater, using electrolysis to extract oxygen from water. Requires Scuba skill to use. Cannot be used in fluids other than water (e.g., methane). 30 lbs., $1,000, 4D (4 hours).

Filter Attachment: For air mask or respirator, used to filter out contaminants; cost depends on what is being filtered. $100 to $1,000; 1 lb. Filter medium must be replaced periodically; again, cost varies from a $10 cartridge (to filter heavy dust or pollen) to replacing the whole mask (in a chemical-warfare environment).

Life-Support Pack (LSP): Provides heat, cooling, and energy for a vacc suit's systems. It has DR 3 and 20 hit points. After it takes 10 hits, there is a 50% chance of a malfunction on each further hit. When hit points reach 0, it no longer works; the user's survival time depends on the environment. $500, 5 lbs., 2C (1 day).

Respirator: Makes thin or low-oxygen atmospheres breathable by concentrating the oxygen. Often combined with goggles to protect eyes from the effects of thin air. Includes a short-range communicator. $300, 3 lbs., B (1 month).

Thermo Suit: A sealed, neck-to-toe suit built to wear with a standard vacc-suit helmet. It is designed for very cold environments. In cryogenic conditions such as Titan, it must be used with heated air tanks and a life-support pack (above). It is heavily insulated (especially the boots). As long as the LSP is operational, the suit provides total protection against extreme cold. It gives +20 to effective HT for all rolls to resist freezing, even if the pack is turned off. PD 1, DR 2. $500, 10 lbs.

SPACE EQUIPMENT

Personal Re-entry Kit: A foamed ablative heat shield, chemical thruster, and parachute that allow someone in a vacc suit to make an aerobraking atmospheric re-entry from orbit. Roll vs. Free Fall skill (to re-enter without burning up) and then Parachuting (to land safely). $15,000, 30 lbs.

Thruster Pack: A cold-gas thruster harness for short jaunts in free fall. It provides 50 lbs. of thrust – enough to accelerate an average human in a vacc suit by 3 yards/second each turn. The large nitrogen gas cylinder allows 100 seconds of full acceleration. Successful Free Fall rolls at +3 allow the user to control his speed and direction. $2,000, 20 lbs. (including cylinder). Extra cylinders are $30, 10 lbs.; 5 seconds to replace.

TOOLS AND INDUSTRIAL EQUIPMENT

This equipment is used to build, fix, or maintain material goods.

TOOLS

Basic Tool Kit (Armoury or Electronics): Minor and major repairs can be made at no skill penalty. $1,200, 100 lbs.

Basic Tool Kit (Engineer or Mechanic): Minor and major repairs can be made at no skill penalty. $800, 300 lbs.

Portable Tool Kit (Armoury or Electronics): Minor repairs are at no skill penalty, major repairs at -2. $900, 10 lbs.

Portable Tool Kit (Engineer or Mechanic): Minor repairs are at no skill penalty, major repairs at -2. $600, 20 lbs.

Mini-Toolkit (Armoury or Electronics): Minor repairs are made at -2 to skill, major repairs at -4. $400, 2 lbs.

Mini-Toolkit (Engineer or Mechanic): Minor repairs are made at -2 to skill, major repairs at -4. $400, 2 lbs.

Duct Tape: Will stick to almost anything. $5, 2.5 lbs. for 200 feet.

Explosives, Plastic: A standard "brick" of octonitrocubane explosive. Does 6d × 8 per pound. $20, 1 lb. LC 4.

Explosive, Metal: A stabilized metallic-hydrogen explosive. Does 6d × 12 per pound. $40, 1 lb. LC 3.

Hive Pack: A lunchbox-sized unit for carrying up to four hexes of cyberswarm. Can be clamped onto a cybershell, worn as a backpack, etc. Includes recharging points enabling the swarm to recharge from a power system or the included C cell. $200, 1 lb. empty; 2-5 lbs. full.

Analysis Hive: See *Explorer Swarm* (p. 170). Includes a C cell. $1,000, 20 lbs.

MANUFACTURING EQUIPMENT

3D Universal Printer

A minifacturing system used to build solid objects by precisely painting various materials, layer by layer, until the object takes form. Given 3D blueprints (see p. 143), it can build just about anything that fits inside it, using cartridges of self-assembling smart ink, liquid plastic, carbon nanotubes, metallic powders, and so on.

Small Printer: Prints $100 worth of goods per hour. $250,000, 100 lbs. and 5 cf. LC 4.

Large Printer: Prints $500 worth of goods per hour. $1,000,000, 500 lbs., 25 cf. LC 4.

Optimized Printer: Identical to universal 3D printer, but it can only work on a specific category of materials; e.g., plastics, synthetic fabrics, or metals. Thus, a 3D polymer printer could make a gun's frame but not its barrel, action, or ammunition. It takes about an hour per pound of mass to print. Has 20% cost, weight, and volume. LC 5.

Operating Costs: To have the correct materials on hand for a given item, the user should have stockpiled material equal to about five times the item's weight and cost (for universal printer cartridges) or equal to its weight and cost (for optimized printer cartridges). *Printing* an item with a 3D printer run consumes material stocks equal to the item's weight and half of its cost. See also *3D Blueprints* (p. 143) for possible royalty costs. Printer maintenance costs will be 1% of printer cost per 100 hours of operation.

> **Give me a lever long enough and a fulcrum on which to place it, and I shall move the world.**
> **– Archimedes**

Modular Robofac

This is an array of optimized and universal 3D printers supported by automated production lines and storage warehouses. It can be configured to build just about any product. It occupies a few city blocks and can support the industrial requirements of about 10,000 people. A typical modular robofac consists of about $1 billion worth of 3D printers, cybershells, and assorted software (install whatever systems are appropriate to the situation). Weight is 50,000 tons and volume is 5,000,000 cf, including assembly space, warehouses, and parts; power consumption is 10-100 MW. Power requirements vary by process: heavy industrial activities (e.g., making steel) are more energy-intensive. Robofacs optimized for a limited product (e.g., "consumer electronics" or "small arms") are 10% the cost, mass, and volume.

Biofac

A biochemical manufacturing module, similar to a 3D printer but optimized for working with proteins. It gives no bonus to skill for minor tasks, and a -5 penalty when working on major projects. $50,000, 500 lbs., 100 cf. Requires 0.5 kW of power.

SECURITY, SURVEILLANCE, AND COVERT-OPS EQUIPMENT

Widely used by everyone from government agencies to voyeurs.

Burglary Tools

Electronic Lockpick: A sensor/decoder that gives +3 to Lockpicking or Electronics Operation (Security Systems) skill rolls to open any electronic lock. Uses an A cell. $750, 1.5 lbs. LC 4.

Gremlin Microbots: See p. 170.

Laser Listening Device

Bounces a laser beam off a solid surface, detecting and translating the vibrations set up in the surface by nearby voices or other sounds. It can be used through a window and set to upload into a recorder or computer. It has a 1,000-yard range. $600, 6 lbs., C (12 hours).

Nanobug

A tiny (1/20") sensor/recorder unit. Its nanocamera lens and microphone can scan a room. It can store two hours of TV-quality digital images, with sound. The mike can pick up voices clearly within 5 yards. The bug can run constantly, listen for a specific voice before recording, scan at specific times of day, or scan when its sensors detect light or body heat in the room. It includes a burst transmitter and radio receiver (range 5 miles) that can transmit all recorded data in a burst lasting a few seconds upon receiving a coded radio command (or be set to do so after a specific time has passed). Once it transmits, it may be programmed to erase everything it has stored and begin recording again, or to self-destruct. $100, AA (1 year). For $100 more, it can self-destruct if tampered with (Demolition or Traps roll at -3 to defuse).

Emissions Nanobug: As above, but instead of audiovisual sensors, it has field-emission sensors that can read data being sent to or from an electronic device it's in direct contact with. It *cannot* read data that is simply sitting on a hard drive or the like. Other stats are as per a regular nanobug.

Microbot Nanobug: A single, tiny microbot spy. As a regular nanobug, above, but add any microbot swarm chassis (p. 168) at 1% the usual cost. Mobility is as per a cyberswarm. One hit destroys it. Size Modifier is -16; this only applies to ranged attacks.

Restraint Devices

Cufftape: Looks like duct tape, but the sticky side is a memory polymer that tightens if the prisoner struggles. A 2' strip is sufficient to restrain arms or legs. It has ST 20. To break free, win a Quick Contest of ST or make an Escape roll at -5. The first try takes 1 second; further attempts require 10 minutes' struggle. Each failure does 1 hit of damage to the taped area. Cufftape has DR 3; 6 points of cutting or fire damage severs it. $10, 0.5 lb. per 100-foot spool.

Smart Blindfold: A rugged pair of virtual interface glasses (p. 142) that locks onto a subject's head, with external control of its functions. It can control the augmented reality perceived by the wearer, as well as see and hear what the prisoner does (and if desired, record it). The visor can also blank out the prisoner's vision or (by projecting white noise) hearing. It can be controlled by any external interface with the proper codes, or by its own digital mind. DR 10, 2 hits. Its batteries cannot be removed without unlocking it. Otherwise identical to a VIG frame, but at 1.5 times the cost and 2 times the weight.

Surveillance Dust

Microbot swarms (pp. 168-171) with a dust chassis (p. 168) and the surveillance function (pp. 170-171) are among the most common means of spying.

WEAPONS

The majority of 2100-era weapons resemble the firearms of the previous century, but with integral electronics such as computerized sights and safety systems. One change is the ammunition: most guns use cased telescoped or caseless ammunition, and a variety of "smart" ammo is available.

A significant change is the development of small "mini" or "micro" missile launchers the size of pistols or rifles. First introduced by the U.S. Army in the 2020s, these small-caliber grenade launchers fire tiny homing missiles with nanoelectronic guidance systems and explosive warheads.

Vehicles use lasers and electromagnetic railguns, but power limitations prevent their widespread adoption as personal weapons. The exception is the electrolaser stun gun, which uses a low-powered laser as a carrier for an incapacitating electrical shock.

Many weapons are "double barrel" systems with two weapons in one integrated package or pod. The most popular combines a conventional automatic weapon or electrolaser with a mini-/micro-missile or grenade launcher.

Weapons Pods: These "arm guns" are worn strapped to the forearm (missile pods can also be clamped to a combat helmet). They are aimed using a virtual interface; without an interface, they suffer -3 to Acc.

PORTABLE WEAPONS

Anti-Materiel Rifle (AMR), 15mm: A heavy, semi-automatic rifle designed to kill battlesuits or RATS.

Assault Pod: A weapons pod that combines a 4mm light automatic weapon and 4-shot 15mm micro-missile pod.

Battle Rifle: A double-barreled assault rifle combining a 5.6mm light automatic weapon and 30mm mini-missile pod.

Electrolaser Pistol: A low-powered electrolaser.

Electrolaser Rifle: A powerful electrolaser.

Micro-missile Pod: A weapons pod containing a four-barrel muzzle-loading launcher for 15mm micro-missiles. Each guided missile has nano-optic guidance and a 15mm warhead.

Mini-missile Pod: A weapons pod containing a three-shot rotary launcher for 30mm mini-missiles. Each guided missile has nano-optic guidance and a 30mm warhead.

Personal Defense Weapon (PDW), 4mm: A light automatic weapon with an ergonomic shape (similar to the modern FN P90). Its magazine is mounted atop the weapon, rather than in the pistol grip. It fires high-powered 4mm bullets.

Personal Defense Weapon (PDW), 10mm: A larger-caliber PDW firing lower-velocity pistol ammunition.

STUN WEAPONS

Electrolasers: These use a low-powered laser to ionize the air, following it instantly with an electrical charge that travels along the laser path to the target. Roll damage normally, but instead of actually taking damage, the target must make a HT roll with a penalty equal to half the "damage" that got past DR (round up). Failure means he is incapacitated for 20-HT minutes, and at -2 DX for a further 20-HT minutes after recovering. Electrolasers are at -2 to hit in humid environments and -6 in rain or heavy fog. They do not function underwater, or in trace atmospheres or vacuum. Metal armor attracts the bolt: +2 to hit if target wears 20+ lbs. of metal.

Shock Glove: An insulated glove capable of delivering a powerful shock. Touching, punching, or grappling someone has same effect as a hit by an electrolaser. $400, 1 lb., B (500 hits). LC 5. If built into armor, increase the suit's cost and weight by that amount.

Pistol, 4mm: An ordinary pistol using the same ammo as the PDW 4mm, but with a shorter barrel.

Pistol, 10mm: A heavy pistol using the same ammo as the PDW 10mm.

Police Armgun: A weapons pod combining an electrolaser pistol and 4-shot 15mm micro-missile pod.

Recoiless Rifle, 15mm: A rifle-like weapon which fires 15mm projectiles and counters recoil by venting cold gas out the back of the weapon. Favored in zero-G combat.

Recoiless Rifle, 60mm: A shoulder-fired antiarmor weapon using 60mm rocket-assisted projectiles. Single-shot and breech-loading, it counters recoil by expending plastic flakes out the back of the weapon.

HEAVY WEAPONS

These are too big to be carried by most (or in some cases, any) humans. They are usually installed in vehicles or cybershells, but can also have tripod mounts. A tripod mount negates the weapon's ST requirement, but the weapon may only be fired by someone sitting or kneeling behind the weapon. It takes 30 seconds to attach or remove a tripod mount, and 3 seconds to set up a tripod-mounted weapon in a firing position.

Emag Cannon, 15mm: A high-velocity electromagnetic railgun. Tripod: $2,000, 200 lbs.

Light Laser, 2.5 MJ and *Heavy Laser, 10 MJ:* These are typical vehicular laser cannon. Use these statistics when spacecraft fire their lasers against targets in atmosphere; range in space is 20 times greater.

WEAPON TABLE

Weapon	Type	Damage	SS	Acc	1/2D	Max	Wt.	RoF	Shots	ST	Rcl.	Cost	LC
Beam Weapons (Electrolaser)													
Pistol, Electrolaser	Spcl.	2d+1	8	4	60	120	1	1	200/B	–	0	$1,200	4
Rifle, Electrolaser	Spcl.	3d+1	9	12	100	300	4.5	1	100/B	–	0	$1,800	4
Beam Weapons (Electrolaser) & Guns (Missile)													
Police Armgun:							5.6					$2,000	2
– Electrolaser	Spcl.	3d+1	8	12	100	300		1	200/B	–	0		
– 15mm missile	Cr.++	6d	8	10	500	500		4~	4	–	0		
Guns (Light Antitank Weapon)													
Recoilless Rifle, 60mm	Cr.++	9d	17	8	330	2,850	35	1/3	1	12	0	$2,050	0
Guns (Light Automatic)													
PDW, 4mm	Cr.	3d+2	11	8	380	2,700	2.1	12*	100	8	-1	$560	2
PDW, 10mm	Cr.+	3d	12	7	200	1,900	5.9	12*	60	9	-1	$685	2
Guns (Light Automatic) & Guns (Missile)													
Battle Rifle:							11					$890	1
– 5.6mm lt. auto	Cr.	6d	12	9	530	3,300		12*	100	10	-1		
– 30mm missile	Cr.++	12d-1	12	10	500	500		3~	3	–	0		
Assault Pod:							3					$690	1
– 4mm lt. auto	Cr.	3d+2	9	8	380	2,700		12*	100	9	-1		
– 15mm missile	Cr.++	6d	9	10	500	500		4	4	–	0		
Guns (Missile)													
Micro-missile Pod	Cr.++	6d	9	9	500	500	0.62	4~	4	–	0	$380	3
Mini-missile Pod	Cr.++	12d-1	9	10	500	500	3.8	3~	3	–	0	$410	2
Guns (Pistol)													
Pistol, 4mm	Cr.	3d	9	4	250	2,100	1.5	3~	50	8	-1	$560	3
Pistol, 10mm	Cr.+	3d	9	4	200	1,900	2.75	3~	20	10	-2	$610	3
Guns (Rifle)													
AMR, 15mm	Cr.++	11d+1	17	10	770	4,100	23	3~	10	13	-2	$2,500	1
Recoilless Rifle, 15mm	Cr.++	3d+1	12	8	200	1,900	8.5	3~	10	7	0	$790	2
Gunner (Railgun)													
Emag Cannon, 15mm	Cr.++	9d×5	20	16	2,900	9,400	200/245	20*	750/11E	82	-1	$80,000	0
Gunner (Beams)													
Light Laser, 2.5 MJ	Imp.	100d	30	30	100mi.	300mi.	10,000	1	Veh.	Veh.	0	M$2	0
Heavy Laser, 10 MJ	Imp.	200d	30	31	140mi.	700mi.	37,000	1	Veh.	Veh.	0	M$4.7	-1
MADS	Spcl.	Spcl.	–	–	900	1,800	250/5	1	144/D	69/40	0	$25,000	1

The weapon table uses the same format as p. B208, except as follows:

Type: + or ++ means the weapon uses a large-caliber round that multiplies crushing damage by 1.5 (+) or 2 (++) after penetrating DR. "Spcl." means the weapon uses special damage rules; see the description.

Wt.: If weights are separated by a slash, the second weight is stored in a separate power or ammo pack (usually worn as a backpack).

Cost: M$ = $1 million.

Shots and *ST:* "Veh." means a vehicular weapon. To sustain RoF 1, a light laser needs 5 megawatts and a heavy laser needs 20 megawatts.

Microwave Area-Denial (MAD): Uses a noncoherent beam of high-power microwave energy to heat up the surface layer (down to 1/64 of a inch) of a target's skin, activating pain receptors without causing actual burning. The sensation is similar to touching a hot light bulb, but all across the surface of the body. There is no roll to hit. It affects a line 1 yard wide, increasing in width by 1 yard per 50 yards range. Victims in the path of a microwave projector must make a Will roll each turn before acting. Failure means that they are stunned for one second due to pain; success means they can act, but at -3 on all actions (as per shock). A person with High Pain Threshold is immune to the effect. The microwave projector will not penetrate sealed suits or vehicles with DR 2 or higher. Requires one E power pack. Tripod: $1,200, 120 lbs.

WEAPON FEATURES

HUD Sight: A digital camera built into a weapon and linked to the virtual interface via microcommunicator, allowing the use of *HUD Targeting* programs (p. 145). All personal weapons incorporate HUD sights; buying a gun without one reduces cost by $250.

Laser Sight: Also a standard fit on all ranged weapons, it projects a low-powered laser beam, displaying a dot at the point where the weapon will hit. This gives +2 Acc and reduces the snap shot penalty to -1 at up to 50 yards and -2 at up to 100 yards (it remains -4 past 100 yards).

WEAPON OPTIONS

Articulated Weapon Harness: A support harness that reduces the Minimum ST of the rifle or heavy weapon to which it is attached by 3. $600, 5 lbs.

Gyrostabilized Weapon Harness: An articulated weapon harness that also cancels penalties for walking or running while firing. $2,000, 10 lbs., C (1,000 hours).

IFF Interrogator: A short-range Identify Friend or Foe (IFF) system built into a weapon, preventing it from firing on people with a "friendly" IFF transponder (p. 159). $100.

Recognition Pad: A palmprint or voiceprint biometric analyzer (set for one or the other) built into a weapon's handgrip. It prevents anyone but the registered user from firing the weapon. $100, negligible weight. Required by law in some areas. Can store up to 50 biometric datasets (in the military, this is typically everyone in a platoon).

Smartgrip: The smart-matter grip of the weapon and trigger adjust to the user's strength and hand shape: -1 to SS and +1 to Acc. $500.

AMMUNITION TABLE

Weapon	Shots	Cost	Weight
AMR, 15mm	10	$8.40	2.9 lbs.
Assault Pod, 4mm	100	$1.60	0.56 lb.
Battle Rifle, 5.6mm	100	$4.70	1.6 lbs.
Emag, 15mm	750	$204	25.5 lbs.*
Micro-missiles, 15mm:			
– if Solid	1	$4.50	0.1 lb.
– if MBC, HEMP	1	$4.80	0.1 lb.
– if SEFOP	1	$5.80	0.1 lb.
Mini-missiles, 30mm:			
– if Solid	1	$35	0.8 lb.
– if MBC or HEMP	1	$40	0.8 lb.
– if SEFOP	1	$46	0.8 lb.
PDW, 4mm	100	$1.60	0.56 lb.
PDW, 10mm	60	$4.50	1.6 lbs.
Pistol, 4mm	50	$0.80	0.28 lb.
Pistol, 10mm	20	$1.50	0.53 lb.
Recoilless Rifle, 15mm	10	$4	2 lbs.
Recoilless Rifle, 60mm	1	$13	6.4 lbs.

Statistics for micro-missiles, mini-missiles, and 60mm recoilless shells are for loose rounds. Otherwise, cost and weight is per loaded magazine. Unless noted, costs are for solid ammunition.

* Also requires 11 E-cell power packs.

Smart Ammo

Nanoelectronics make possible cheap, light, and smart ammunition. Smart ammo is usable in any gun that fires projectiles; this includes all weapons on the table not fired using Beam Weapons or Gunner (Beams). Micro-missiles are *automatically* homing at no extra cost. These options cannot be combined.

Stabilized: Contains piezoelectric actuators that tilt the round's nose to correct for wind drift and compensate for gravity. No Acc is lost when firing beyond 1/2D range. ×2 cost.

Homing: The tip of the bullet is a nanocamera array. If an *aimed* shot is fired, the computer can lock onto the target and help correct the bullet's flight path via vectored nozzles which make minor course corrections to stay on target. If aimed, add +3 to skill. Aimed or not, also treat as stabilized. ×5 cost.

Laser-Homing: Identical to homing, but only works if the attacker is using a laser sight or designator. Ineffective if the target is obscured by smoke, prismatic smoke, etc. The Acc bonus is cumulative with the +2 for a laser sight. ×3 cost.

Gestalt: As stabilized, but each round has a quantum-dot laser communicator in the tail. Telemetry is transmitted to following rounds fired in the same second, allowing them to correct their aim to the target should the first round miss, or correct for recoil if on target. This adds a +1 to skill for every attack (single shot or group) fired after the first in the same turn to a maximum of +4; this usually cancels recoil penalties. ×2.5 cost.

Bullet Types

These ammo types are available for projectiles under 20mm size. They can be combined with smart ammo. Cost multipliers are *additive* rather than multiplying with smart-ammo modifiers; e.g., homing APS rounds would be ×10 cost, not ×25 cost.

Armor Piercing: Armor protects at half DR, but damage after DR is also halved. ×3 cost. LC 2.

Armor Piercing Saboted (APS): These rounds use a high-density tungsten-carbide penetrator encased in a much larger plastic sheath. Increase 1/2D and Max ranges by 50% and add +1 to damage per die. DR protects at half value, but damage after penetrating DR is also halved. Not available for missiles. ×5 cost. LC 1.

Drug: Injects one dose of an injectable drug (p. 164). Add the cost of one dose (per shot) to ammo cost. LC as per drug.

Hollow Point: DR protects at ×2 but damage after DR is ×1.5. Normal flesh gives DR 1 against it. ×1.5 cost. LC 4.

Plastic: Does half the damage of regular ammunition and has half the normal range. Normal cost. LC 4.

Tag: The bullet contains a microcommunicator signal tracer detectable within 1 mile. Does normal damage. ×2 cost. LC 4.

Smart Warheads

These are available for weapons firing projectiles of 15mm or larger size. They are bursting or explosive warheads. All have smart fuses, programmable through augmented reality as long as the shooter has a virtual interface or is a cybershell. It takes 2 seconds to reprogram one or more warheads in a weapon.

The warhead's radar fuse can be set to *impact* (detonates where it hits), *proximity* (detonates on a near miss), *time-delay* (detonates up to an hour later; no direct hit effects), or *inert* (no detonation). A miss uses the rules for scatter on p. B119. However, a proximity-fused round will explode 1 hex from the target on a miss by 1, or 2 hexes from the target on a miss by 2 (roll randomly: 1-3 to right, 4-6 to left).

The warhead's effect depends on the warhead type purchased: HEMP, SEFOP, and MBC are common. If the warhead is set to "inert," or is solid, it does the indicated crushing damage instead.

In addition to setting the fuse, the warhead's safety interlock can be set to *free* (detonates as above), *tame* (proximity sensor not triggered by people with friendly IFF), or *safe* (with no detonation if friendly IFF is detected within 15 yards of a 15mm warhead, 30 yards of a 30mm, or 60 yards of a 60mm).

High Explosive Multi Purpose (HEMP) Warhead

A smart explosive warhead that uses octonitrocubane, roughly four times as potent at TNT. HEMP inflicts concussion and fragmentation damage (pp. B121-122). Sealed armor DR is *squared* vs. the concussion damage, but *not* the fragmentation damage. In addition, anyone directly hit takes shaped-charge damage (armor protects at 1/10 DR); laminate armor provides double DR vs. the shaped charge, and electromagnetic armor triples DR. ×2 cost. LC 0.

15mm: 1d concussion and 1d cutting fragmentation; 3d(10) shaped charge.

30mm: 5d concussion and 2d cutting fragmentation; 6d(10) shaped charge.

60mm: 4d×10 concussion and 6d cutting fragmentation; 6d×10(10) shaped charge.

Self-Forging Penetrator (SEFOP) Warhead

A smart-fused explosive warhead that uses a stabilized metallic hydrogen explosive. The warhead inflicts concussion damage (p. B21). On a direct hit, it detonates a foot or so away from the target; the detonation shapes the warhead into a high-velocity, metallic "explosively formed penetrator" that does crushing damage. On a miss, the warhead explodes in a burst of fragments, depending on its safety setting. The warhead will not detonate if friendly personnel are in the area. ×5 cost. LC 0.

15mm: 2d-1 concussion and either 6d(5) crushing or 1d cutting fragmentation.

30mm: 7d+2 concussion and either 6d×2(5) crushing or 2d cutting fragmentation.

60mm: 6d×10 concussion and either 6d×20(5) crushing or 6d cutting fragmentation.

MBC (Microbot-Biological-Chemical) Warhead

Releases a cloud of chemicals or microbots. The effects linger for 300 seconds divided by the wind speed in mph (maximum 300 seconds). Add the cost of the filler – usually either a number of doses of a chemical or a microbot cyberswarm – to the normal base cost of the ammunition.

15mm: Covers 1-hex radius (1 dose).

30mm: Covers 6-hex radius (8 doses).

60mm: Covers 13-hex radius (64 doses) or carries a 1-hex cyberswarm (p. 72).

These options are common:

Biochemical: An aerosol or contact-aerosol drug; see pp. 163-164. LC depends on filler.

Nanoburn: Nanomachines which invade the body and break down bodily functions. This is a contact agent; it has no effect on nonliving things. Roll against HT-6 to avoid paralysis for (30-HT) minutes. If paralyzed, 1d-1 damage occurs every 3 minutes for the duration. Normal nerve-poison antidotes, as well as advantages such as Immunity to Poison, are largely ineffective, but do allow an additional HT roll every 3 minutes; success negates further damage and ends paralysis. $5/dose. LC 1.

Prismatic Smoke: Impairs visually aimed attacks or sighting (-5 penalty) and totally blocks laser fire, laser communications, and ladar into or through it. $2/dose. LC 5.

Hot Prism: As prismatic smoke, but adds hot metallic particles. Lasts half as long, but also impairs infrared- and radar-aimed attacks or sighting (-5 penalty). If breathed without a filter, it inflicts 1 hit/turn. $3/dose. LC 4.

Swarm: Houses a cyberswarm in acceleration-gel cocoon. Add cost of cyberswarm. LC depends on swarm.

Tear Gas: See p. B132. $2/dose. LC 5.

Tangler Warhead

Releases a sticky web which wraps around and immobilizes everything in the area. Neither armor PD nor DR protects against being hit, but anyone hit gets an extra Dodge roll to evade the strands before they close. The strands are too tight and sticky to be cut off. To escape, the victim may attempt one Quick Contest of Strength per minute vs. the strands' ST. If he is fully clothed, an Escape roll at -3 (one try every 10 minutes) will let him wriggle out of his clothes and get free. Multiple tangler hits add +25% to ST and -1 to Escape rolls. A failed attempt to break or wriggle free causes constriction inflicting 1 point of damage (rigid armor with DR 2+ protects against this). Ten of more hits from intense heat will also free the victim, but he takes full burn damage. The strands lose their constricting ability after 24 hours, and then lose 1 ST per two hours. The easy way to remove tangler strands is with anti-tangler aerosol spray ($100, 2 lbs.), which dissolves them instantly. LC 5.

15mm: single target, ST 10, $2.5.

30mm: 1-hex radius, ST 20, $25.

60mm: 4-hex radius, ST 40, $200.

GRENADES

A standard grenade in 2100 weighs 0.1 lb., costs $5, and is treated as a 30mm warhead (see *Smart Warheads,* p. 158); all types except SEFOP are available. Use Throwing skill to throw a grenade; see p. B49. The distance a character can throw a grenade is ST × 3 yards. A grenade is Holdout +3.

Limpets: As hand grenades, but not balanced to throw. Instead, their biomimetic octopus-sucker coating can stick (or unstick) to almost any surface on receiving the correct communicator pulse. They can be used as handheld weapons (with any preset delay) by slapping them on someone. Limpets may also be worn on armor or cybershells as defensive decoys; e.g., limpets filled with prismatic smoke or the like can be set to trigger instantly if laser sensors detect a laser beam. To remove a limpet without the proper code, roll vs. ST-5, one try per second. Pulling them off of flesh does 1 point of damage.

SUITS AND PERSONAL ARMOR

These provide protection against dangerous environments or attack. Unless noted, no more than one layer of armor can be worn.

Flexible armor can be concealed under loose clothing, but is not rigid. If a crushing, cutting, or explosive attack strikes flexible armor, then blunt-trauma injury can occur even if the damage failed to penetrate DR. Every 6 rolled for damage does a minimum of 1 point of crushing damage.

Sealed armor prevents contact-aerosol agents from penetrating. With a sealed helmet, the armor is airtight, but requires oxygen tanks.

Vacc Suits provide vacuum support.

Arachnoweave Armor

This flexible armor is made from biomimetic spider-silk proteins. Strong yet supple, arachnoweave is manufactured in black, gray, or green for military or combat applications, or in bright patterns for sportswear. It can be comfortably worn as an undergarment, taking 2 seconds to slip on or off. It is PD 2, DR 8 (PD 1, DR 2 vs. impaling). $150, 1 lb. for vest, tights, or pants; $200, 2.5 lbs. for a full suit (protects everything but the head). LC 5.

Nanoweave Armor

This flexible armor is a multilayered weave of carbon nanotube fibers plus climate-control systems. The vest covers torso and vitals; the suit covers neck to toe. DR (not PD) is halved vs. impaling attacks.

Light: PD 2, DR 10. $400, 2 lbs., for a vest; $750, 5 lbs. for a full suit. LC 5.

Medium: PD 2, DR 20. $800, 4 lbs. for a vest; $1,500, 10 lbs. for a full suit. LC 4.

Heavy: PD 2, DR 40. $1,200, 6 lbs. for a vest; $3,000, 20 lbs. for a full suit. LC 3.

Nanoweave Vacc Suit

A flexible counter-pressure vacc suit made of multi-layered nanocomposite fiber. It incorporates an extra layer for temperature control. The suit is flexible over the entire body. A helmet is *not* included; select one of the full helmets below. It requires a life-support pack (p. 152). The gloves reduce DX and manual skills by -1. DR is halved vs. impaling attacks.

Light: PD 2, DR 12 to all locations. 15 lbs., $2,000. LC 4.

Medium: PD 2, DR 24 to all locations. 20 lbs., $3,000. LC 3.

Heavy: PD 2, DR 40 to all locations. 30 lbs., $3,500. LC 2.

Suits have PF 1 (light or medium) or PF 2 (heavy) vs. radiation. A heavy suit may add *rad shielding* for an additional $1,000 and 20 lbs. This gives +10 DR, +3 PF.

Clamshell Cuirass

A strap-on back-and-breast plate using metal-matrix laminate composites. It can be worn on its own or over flexible armor. Takes 10 seconds to put on or remove. Protects the torso (locations 9-11, 17-18) only. Three grades are available:

Light: PD 4, DR 25. $280, 7 lbs.

Medium: PD 6, DR 35. $400, 12 lbs.

Heavy: PD 6, DR 55. $600, 18 lbs.

Light Infantry Helmet (LIH)

This resembles helmets used by 20th-century soldiers. It is unsealed and has no built-in accessories such as electronics or a gas mask. It provides PD 4, DR 20 for the top of the head only (location 3-4, the brain). $30, 1.5 lbs.

Full Helmet

A fully enclosed helmet. Worn with a vacc suit, it is sealed and airtight. The faceplate incorporates a digital camera and microcommunicator that can work with the user's virtual interface to allow augmented reality, or to provide vision even when sealed. Takes 2 seconds to put on or remove, plus another second to seal. May have optics (p. 151), computers (pp. 141-145), and communicators (pp. 148-149) built into it, up to a maximum weight equal to its own weight.

Light: PD 4, DR 20. $50, 2 lbs. See also *Mobile Helmet* (p. 123).

Medium: PD 4, DR 40. $70, 3 lbs.

Heavy: PD 5, DR 60. $100, 5 lbs.

Smartsuit

This resembles a nanoweave vacc suit, but made of tougher materials: a 3D molecular weave of smart-matter, machine-phase materials. This acts like artificial muscle, duplicating the wearer's every movement as if the suit were not there at all. Pressure sensors covering the suit's surface feel the shape of whatever the user touches and transmit it through the suit. Its weight does not count as encumbrance to the wearer, although the suit does not enhance strength. The smartsuit is sealed, so with a life-support pack (p. 152) and air tank it can operate in vacuum. The suit "heals" rips on its own.

Statistics are identical to nanoweave vacc suit (p. 159), but multiply cost by 10 and weight by 2. DR protects at full value vs. impaling damage. A D cell powers the suit for 16 hours (light), 12 hours (medium), or 8 (heavy).

A smartsuit is capable of reconfiguring itself on voice command, if the following modular options are added:

Cosmetic: The suit can change its color and hue on request, or even become partially or completely transparent (though not invisible). This is not an actual chameleon suit, but does allow the user to don a camouflage pattern (-2 to be spotted) if desired. Add $2,000.

Interphase: This allows two or more smartsuits in physical contact to slowly merge, effectively becoming a single, larger suit (like a big, tight sleeping bag) with all original occupants. This is useful for intimacy, first aid, etc., without breaching life support. Interphasing takes 10 seconds, and requires that all parties be cooperative, restrained, or not resisting. Interphased suits are clumsy, especially in gravity; basically, you can hop or roll at Move 1. Separating takes the same time; any suit wearer can initiate it. Add $5,000.

Battlesuit

A battlesuit is an armored, strength-amplifying exoskeleton. Thick plates of laminated metal-matrix and nanocomposite armor over shock-absorbing padding protect the wearer. The suit is airtight and pressurized for vacuum, with a radiation PF of 10. It can accept a life-support pack and air tanks. The suit's weight does not count as encumbrance while powered up. If the suit loses power, the wearer can still move – but he must use his own ST to carry the weight!

The helmet has an integral virtual interface frame (p. 125), medium-range radio (p. 149) and laser (p. 149) communicators, and sensor systems equivalent to multi-view optics (p. 151) with a 4× teleview.

The battlesuit clamshells open, allowing the wearer to step in or out quickly (4 seconds to don, 2 to remove). The suit does not need to be customized to its wearer: internal memswear systems adjust the fit. Use Battlesuit skill to operate it. Two examples:

Shenyang H-23: PLA SID scout battlesuit. PD 5, DR 65 torso and head, PD 4, DR 50 elsewhere. ST 20, Move 8. $50,000, 200 lbs. E (4 hours).

Vosper-Babbage Centurion: European Union space force battlesuit. PD 5, DR 70 torso and head, PD 4, DR 50 elsewhere. ST 24, Move 6. $60,000, 220 lbs. E (4 hours).

ARMOR AND SUIT ACCESSORIES

The following options can be added to suits or cybershells:

CBR Filter: A filter attachment rated to keep out military chemical, biological, and radioactive contaminants while allowing fresh air to pass through (removing the need for an air supply). Add to any sealed helmet. $200, 1 lb. Spare filters (replace every 48 hours of use) are $40, 0.25 lb.

Chameleon: The surface of armor (or another object) can be coated with smart electrophoretic inks designed to alter coloration to blend it into the background. A moving wearer is -1 to be hit or visually spotted. If a wearer remains stationary for at least 2 seconds, the suit gives a -2 penalty after 2 seconds and a -3 after 3 seconds or more. $1,000, LC 5.

IFF Transponder: Sends a "friendly" code when targeted by a friendly sensor or weapon with an IFF interrogator. $100, negligible weight, A (1 year).

IR Cloaking: Blends the wearer's heat signature into the background, giving a -3 penalty to infrared spotting and targeting, and a -10 on IR-homing projectiles' chance to hit. $1,500, 5 lbs., 2B (24 hours).

Laser Sensors: Detect the "touch" of a laser sighting beam and alert the wearer, giving him +1 to dodge an immediate laser-aimed attack. Also detect and warn of laser designators trained on the wearer. $2,000, 2 lbs., C (3 months).

Near Miss Indicator (NMI): Detects the flight path of projectiles passing within 5 yards (attack roll missed by 4 or less). Gives +2 to Vision rolls to pinpoint the source of fire. $1,000, negligible weight, A (2 months).

Radar Detector: Alerts the user if he's in the path of a radar beam, at up to twice that radar's range. $50, negligible weight, A (1 week).

Reactive Armor Paste: This sensor- and prism-embedded directional-explosive nanopaste can be lathered onto armor or flesh. It explodes outward to disrupt and partially counter impacts and beam-weapon strikes. One explosion occurs per attack (or group of shots from an automatic weapon). It provides an extra DR 20 against beams or projectiles, or DR 5 against melee or thrown weapon attacks. The wearer takes 1d explosive concussion damage per attack (or group of shots); DR under the paste will protect normally against this damage. A single coating is effective against 3 attacks (or groups) on each limb and the head, and 6 attacks on each of the front and back torso. $200, 4 lbs. per 10 square feet (enough to coat a human).

MEDICAL CARE

2100-era medicine is extremely effective. If a person can be kept alive, and Fifth Wave medical care is available, then only injuries and diseases that rapidly destroy the brain or nervous system are likely to be fatal.

LIMB AND ORGAN REPLACEMENT

Transplants are tissue-engineered rather than provided by donors. It takes 6 weeks to custom-grow tissue using tissue-engineering techniques, or a week to do the same using biogenesis. Typical cost to grow a single limb, eye, or organ is $5,000 (doubled for biogenesis). The actual transplant operation might cost another $10,000 per part replaced. With limb transplants, full functionality is not attained for 6 weeks following the operation.

BIOMOD TRANSPLANTS

These are common tissue-engineered genemod organs. They provide the user with an advantage (point cost in brackets), but must be custom-grown in advance, and require a transplant operation and time to recover. See *Biomods,* p. 131.

Andraste: This series of genemod organ transplants allows the recipient to breathe Martian air. Gives Mars-Adapted [14] (p. 131). $14,000 (5 weeks to grow, 7 weeks to recover).

Bio-Booster: An adrenaline pump designed to supercharge the body in emergencies. Gives Hyper-Reflexes (Cardiac stress, -40%) [9] and Hyper-Strength (Cardiac stress, -40%) [18]. Cardiac stress means a HT roll is required every 10 seconds. Failure causes 1d of fatigue; critical failure means a heart attack (go to 0 HT, pass out, and die in HT/3 minutes unless given CPR, which requires a First Aid-4 or Physician roll). $13,500 (4 weeks to grow, 2 weeks to recover).

First Aid and Physicians

First aid takes 10 minutes and restores 1d damage, but requires the use of bandage spray (p. 162). If the spray is unavailable, then first aid takes 20 minutes and repairs 1d-1 damage. Medical care by a physician is treated as TL9 on p. B128.

Boosted Heart: Implanted genemod muscle tissue and modified ventricle construction enhance strength and resiliency. Gives Extra Fatigue +1 [3] and Hard to Kill +1 (Bonus also applies to Aging rolls and rolls to avoid heart attacks, +20%) [6]. $14,000 (6 weeks to grow, 8 weeks to recover).

Flesh Pocket: A secret pouch implanted in the body. Gives Flesh Pockets (p. 131) (1 lb. capacity) [2]. $1,000 (1 day to grow, 1/2 day to recover).

Liver Upgrade: This filters out toxins, giving Alcohol Tolerance [5] and Resistant to Poison [5]. $10,000 (6 weeks to grow, 4 weeks to recover).

No-Shock Glands: Gives the user High Pain Threshold (Limited use, 4 per day, -20%; Nuisance effect: -1 DX and IQ when activated and for one hour afterward, -20%) [6]. $12,000. (2 weeks to grow, 1 week to recover).

Retinal Enhancement: Gives the user perfect vision. Corrects Bad Sight, or adds Acute Vision +1 [2]. $5,000 (1 week to recover).

CLONING

A clone is a genetic duplicate of a person. It normally has a slightly different appearance, since many features develop after conception (such as fingerprints). The GM should decide which advantages and disadvantages reflect heredity and which represent acquired characteristics.

A human or animal clone can be created by taking a live tissue sample of a person, removing cells, and carefully starving them until they become still living but quiescent. The donor cells are then fused with an egg cell taken from a female of the same species; the egg cell's own nucleus (with its DNA) is removed. This procedure takes about 3 days and costs $500. Now awakened, the egg cell, with donor nucleus, forms embryonic cells that can be implanted after a week or so in the donor (if female), or a surrogate mother or exowomb (p. 163). It then develops like any other embryo, becoming a fetus and then a baby. Clones do not grow unusually fast or share an original's memory.

Cross-Sex Clones: Chromosome manipulation can change a clone's sex but keep it otherwise identical. This takes 1 week and costs $10,000 for a male-to-female change, or 3 weeks and $35,000 for female-to-male change.

Clones and the Law: Human clones have full civil rights; it is usually legal to clone oneself, but cloning another requires his permission (or that of his estate). Rights of parents to clone their children vary. Genetic upgrades, parahumans, bioroids, and sapient uplifts may have copyrighted genomes.

MEDICAL EQUIPMENT

Anti-Toxin Kit: Neutralizes one specific non-nanotech toxin. 10 uses. $25, 0.5 lb.

Bandage Spray: One-use can; seals and disinfect most minor wounds. $15, 0.1 lb.

Biomonitor: A "Doc in a Box" gives a medic readouts on his patient's vital signs (+2 to Medical skills). It can interrogate diagnostic nano (to obtain blood, biochemical, and microbiological samples) and determine pulse, electrocardiogram, blood pressure, and respiratory rate. Sensors and ultrasound transducers must be attached to the patient for diagnostics and communication with nano. $5,000, 0.5 lb., A (1 year).

Cyberdoc: A robot doctor; see p. 122.

Diagnosis Table: An examining table with a full range of biological and medical scanners using T-rays and ultrasound, plus an acoustic communication system for controlling diagnostic nanobots. The diagnostic table can monitor the patient's parameters remotely, unlike the portable biomonitor; the patient lies on the table and scan results are projected onto an overhead screen. Gives +5 to Diagnosis skill, or +7 if used with a HyMRI (p. 163). $12,000, 250 lbs., 80 cf.

Drug Patch: Self-sticking patch soaked in a premeasured dose of a specific drug. The most common are painkillers and antibiotics. $10+, negligible weight.

Emergency Support Unit: The ESU is used to stabilize critically ill patients. It assists or replaces heart and lung function once connected. A skilled operator can hook someone up in 10 seconds. It can maintain the biological functions of someone who is clinically dead (but not at or below -5 × HT) and perform whole-blood transfusions. A blood-wash (removing nanomachines in the bloodstream) takes 2 hours. $15,000, 120 lbs.

Enzyme-Blocking Drug: Gives +8 to HT rolls to recover from a specific disease. $5/dose.

Medkit, Emergency: Gives +1 to First Aid skill. $150, 1 lb.

Medkit, Paramedic: Gives +2 to First Aid skill, and allows Diagnosis, Physician, and Surgery skills to be used at no penalty. $750, 7.5 lbs.

Medkit, Vehicle: Gives +2 to First Aid skill, and +1 to Diagnosis, Physician, and Surgery skills. $5,000, 50 lbs.

Nanostasis Pod: A sealed, padded, and shielded pod that enables a person to be carried safely as cargo while in nanostasis. Provides radiation PF 10. $5,000, 0.5 ton, 50 cf.

Plastiskin: 6" × 6" patch of artificial skin. $10, negligible weight.

Pneumospray Hypo: An air-shot hypodermic with 100 shots (extras $10, negligible weight). $125, 0.25 lb.

Medical Microtech and Nanotech

These are injected into a patient's body.

Bionet: This is a network of microbots with acoustic transmitters, designed to spread through the body and serve as a communications relay system, receiving biochemical signals from smaller medical nano. It takes an hour to circulate through the body. It must be installed before radical nanosurgery or the use of programmable immune machines. It allows diagnostic nano to report *without* having to retrieve them; this lets the nano remain in the patient, providing constant updates. $1,000/dose. Will degrade harmlessly within a month.

Diagnostic Nano: Tiny robots used to determine what is wrong with a patient. Adds +5 to Diagnosis skill; can also identify nanomachines, such as the proteus virus. Takes two hours to circulate through body and diagnose problems, and another hour to retrieve. The patient must be attached to a diagnostic bed, cyberdoc, or ESU. Alternatively, a bionet can be established and the diagnostic nano can report more rapidly and constantly. $2,000/dose. Can be retrieved using an ESU or cyberdoc, or will degrade harmlessly in a month.

Programmable Immune Machines: These are nanomachines that can be programmed to destroy specific viral, bacterial, or parasitic infections, cancers, or nanosymbionts. The target must have been correctly diagnosed for them to function. A Physician roll is needed to program them for a target (this takes half an hour). If the roll was a success, they will destroy their target within an hour; if it failed, they have no effect (try again). $500/dose.

Surgical Microbots: Miniswarm of microbots optimized for internal procedures, controlled through a bionet. Adds +4 to any Surgery roll, or allows internal surgery that is otherwise impossible. Not usable for nanosurgery or brainpeeling. Reusable. $15,000, 0.1 lb. LC 5.

Exowomb

An artificial womb tank that can be used to grow a multicellular animal (such as a human) from gametes to healthy adulthood. This is no faster than natural growth. An organism developing in an exowomb has the same awareness as a baby in its womb. If kept past the fetal stage, it will not develop mentally in the absence of stimuli. An exowomb requires a Complexity 4+ computer to monitor life support. A womb for a human-sized organism is $100,000, 250 lbs., 50 cf. It runs on building or vehicle power (0.1 kW). Renting an exowomb costs $3,000 per month.

Hypersensitive Magnetic Resonance Imager (HyMRI)

A high-definition magnetic resonance imager, commonly used to see inside the body and diagnose problems. HyMRI uses superconducting magnets and spin-polarized gases for maximal contrast enhancement. The gases (xenon-129 or helium-3) are *hyperpolarized,* using laser light to increase the proportion of atoms spinning in the same direction. They are then inhaled or injected. The HyMRI is further enhanced by exploiting intermolecular quantum effects, giving resolutions far better than 20th-century designs (down to 2 nanometers). A HyMRI can also be used in psychiatry, focusing intense fields on areas of the brain. $250,000, 500 lbs., 10 cf. Runs off building/vehicle power. LC 4.

NANODRUGS

Drugs may come as pills, injectable liquids, aerosols, patches, etc. Most are available in multiple forms. Many are actually encapsulated nanofactories that manufacture proteins and nanoviruses to adjust the user's biochemistry. Those that affect the user's brain chemistry are commonly known as "brainbugs." Developments in neurochemistry allow safe drugs to be designed deliberately to produce varied effects.

Effects: Select one or more of these advantages or disadvantages (those marked * must have at least long-term duration): Absent-Mindedness, Acceleration Tolerance, Alcohol Tolerance, Alertness 1-2, Attentive, Autotrance, Bad Temper, Berserk, Bestial, Blindness, Collected, Combat Paralysis, Combat Reflexes, Composed, Cowardice, Deep Sleeper*, Delusions*, Disease-Resistant*, Dreamer, Edgy, Eidetic Memory (no skill bonus, -70%), Epilepsy, Extra Fatigue 1-5, Flashbacks, Gullibility, High Pain Threshold, Imaginative, Imperturbable, Lazy, Lecherousness, Less Sleep 1-5*, Manic-Depressive, No Hangover*, Overconfidence, Paranoia, Pious, Radiation Tolerance 2*, Rapid Healing*, Short Attention Span, Single-Minded, Slave Mentality, Solipsist, Sterile, Truthfulness, Unfazeable, Weak Will 1-4, Very Rapid Healing*.

Drugs may also cause slow, regular, fast, or instant *degeneration:* treat as Regeneration (p. CI64), but *losing* hits instead.

As well, a drug may *mitigate* any of the disadvantages listed above (depending on their cause), along with Chronic Depression, Insomniac, Migraine, Motion Sickness, Space Sickness, and some types of Terminally Ill, canceling the effects for as long as the drug is taken.

Duration: Select the duration. A drug's effects may be short-term (lasting [25-HT] minutes), medium-term (lasting [25-HT]/4 hours), long-term (one full day), or very long-term (up to a week). Multiple doses generally extend duration rather than increasing effect.

EXAMPLE NANODRUG

"Cry Baby!" neuro-agent.

Effects: Cowardice [-10], Weak Will 1 [-8].

Duration: Short-term – (25-HT) minutes.

Agent: Aerosol – HT-4 to resist.

Cost: $72/dose. *LC:* 3.

Agent: A drug may be a pill, injection, aerosol, contact agent, or aerosol contact agent. Pills take effect in 30 seconds and can be dissolved in drinks. Contact agents (patches) take 5 minutes. Aerosols or injections take effect immediately. A user gets a HT roll to resist any disadvantage. Roll at HT-6 if the drug is an injection or pill, HT-4 if aerosol, and HT-2 if contact agent.

Cost: Cost is the sum of the absolute point values of all advantages and disadvantages the drug simulates, multiplied by a base cost for duration: $2 for short-term, $10 for medium-term, $50 for long-term, and $250 for very long-term. For example, a medium-term 15-point advantage or -15-point disadvantage would cost $150. Multiply cost by 2 for aerosol or contact agents, or by 10 for aerosol contact agents.

LC: Drugs are LC 5 unless they induce more than -10 points of disadvantages, in which case they are LC 4. Reduce LC by 1 for aerosols or contact agents, 2 for aerosol contact agents.

Cheap Drugs: These are produced in "black" labs that lack quality control, and are generally half as expensive. Roll 3d whenever someone takes cheap drugs. On a 15 or 16, the drug fails to work at all; on a 17 or 18, it also has a nasty side effect (GM's option, ranging from 3d damage to acquiring a disadvantage like Paranoia or Short Attention Span for the drug's duration).

Drug Addiction: Modern drugs are not physically addictive. However, a drug that produces effects that empower an individual or let him escape from his troubles (GM's option, may depend on the user) may result in psychological dependency if more than one dose is taken in a 2-day period (roll vs. Will to avoid addiction, at -1 per extra dose taken). This results in the Addiction disadvantage (see p. 132 for rules for psychological dependency). The GM may also assign other effects (see *Popular Brainbugs*).

Mnemotropins

Drugs taken to assist in memory. An mnemotropic regime allows acquisition of skill points at twice the normal rate. Costs $100/week.

POPULAR BRAINBUGS

Hobbes: This suppresses the user's reasoning ability; the user regresses to a more animalistic behavior pattern. He acquires the disadvantage Bestial. Often taken deliberately as a form of therapy.

Kujang: This brainbug causes the user to experience the flow of time as if everything were slightly slowed down. He gains Combat Reflexes (those who already have Combat Reflexes get *twice* the usual bonuses!). Excessive use can produce effects similar to post-traumatic stress syndrome. The user must roll vs. Will once per day of use to avoid acquiring the Careful disadvantage or, if he already has Careful, Paranoia. Roll vs. Will again when the bug wears off. On a failure, the disadvantage becomes permanent.

Metatron: This jacks up the user's mystical faculties, leaving him feeling that revelation is around the corner. He gains the advantages of Autotrance and Pious. However, he must make a Will roll daily to avoid acquiring the Delusion that he has the Illuminated advantage (p. CI38), and another Will roll weekly to avoid being driven to acquire Disciplines of Faith (p. CI89).

Nepenthe: The most popular "feel-good" brainbug. The user is unable to feel really sad or afraid, regardless of what happens to him. This brainbug temporarily deactivates disadvantages such as Chronic Depression or the depressive part of Manic-Depressive. This amounts to Imperturbable (Negative emotions only, +0%).

Zero: The user becomes a sociopath. He gains Bloodlust and Solipsist, and *loses* (if he had them) Combat Paralysis, Honesty, and Pacifism.

NANOSYMBIONTS

Nanosymbionts are colonies of bionanomachines installed in a host's body to perform useful services. Nanosymbionts may be permanent residents or temporary lodgers. They can be used by anyone with a biological body. Bioshells can use any nanosymbionts that affect the body, but not those that affect the brain.

Ephemeral Nanosymbionts ("Temp Nanomods")

Temp nanomods are the usual form of Fifth Wave medical care. A doctor will analyze someone's condition, then prescribe appropriate nanomods. A typical temp nanomod comes in a sterile package housing a bee-sized capsule. This contains the applicator-programmer and billions of tiny nanomachines.

The user may set a temp nanomod's duration for anywhere from 1 day to 2 weeks. Once set, it cannot be changed. The user then swallows the nanomod capsule, which takes effect within 1 hour. (Exception: respirocytes take effect within 1 minute.) The applicator-programmer capsule will be excreted normally, while the nanosymbionts remain within the body for the set duration.

It is possible to buy *cheap* temp nanomods at half cost. If using cheap nanomods, roll 3d. On a 17 or 18, they malfunction. Add +2 to the roll for every other nanomod (permanent or temporary) that the person is using at the same time. Malfunctioning nanomods generally inflict 1d-2 (minimum 1) points damage per day until they are destroyed or wear off, with side effects similar to fever. At the GM's option, other nasty side effects related to the nanomod's function are possible.

Permanent Nanosymbionts ("Perm Nanomods")

These are a more expensive version of temp nanomods, since they must be designed with long-term durability and self-repair capabilities. As they provide permanent advantages, the GM may optionally charge character points for them. They operate for an indefinite period, but otherwise function as temp nanomods.

Examples of Nanomods

Various nanosymbionts are described below. The point cost applies only to permanent nanomods. The lower of the two prices given is for temp nanomods; the higher price is for permanent nanomods. Updates to permanent nanosymbionts that destroy "known" bacteria, viruses, or whatever are regularly available, costing about 1% of the original purchase price.

Artery Cleaners: Use tiny biomechanical brushes, cilia, and rotors to clear plaque and fatty deposits from arterial surfaces, reducing the risk of heart disease. If someone who has been using artery cleaners for at least six months would lose a point of HT due to a failed aging roll, roll 1d: on a 1-3, they don't lose the HT. $100/$5,000.

Bacteriophages: Patrol for and destroy known bacterial and parasitic pathogens (no effect on viruses). They give Immunity to Disease (Known bacteria only, -60%) [4]. $200/$10,000.

Brain Boosters: Increase nerve-firing rates and improve neural connectivity. Add Enhanced Time Sense [45]. $2,250/$112,500.

Carcinophages: Patrol for and destroy any cancers in the body. They give Immunity to Disease (Affects cancers instead of disease, -70%) [3]. Permanent mods also defer the age at which aging begins, and at which rolls increase in frequency, by 10 years. $150/$7,500.

DNA Repair: Repair damage to cellular genetic material from aging processes and radiation. They give Slow Regeneration (Only heals radiation, -60%) [4], healing 10 rads every 12 hours. Permanent mods also defer the age at which aging begins, and at which rolls increase in frequency, by 10 years. $200/$10,000.

Guardians: Seek and destroy any nano *not* already resident in the body when they were implanted. If a HT roll is allowed to resist, such as for nanoburn (p. 158) or proteus virus (p. 165), they provide a +8 to resist. If none is allowed, they destroy nano on 14 or less (one try only). This is treated as Panimmunity 2 (Nano only, -40%) [3]. $150/$7,500.

Immune Machines: Enhanced-immune system nanobots. They provide Panimmunity 1 ($20/$1,000) [2] or Panimmunity 2 ($100/$5,000) [5].

Lung Cleaners: Roam the lungs to remove inhaled debris and harmlessly encapsulate and recycle it. They provide Filter Lungs [5]. $250/$12,500.

Metabolic Regulators: Allow the user to regulate his metabolic rate by transmitting commands to the nanomods. He must have a virtual interface implant (p. 150) to do so. They give Metabolism Control 2 [10]. $500/$25,000.

Microgravity Biochemistry: Make metabolic adjustments to prevent degeneration in microgravity or zero gravity, providing No Degeneration in Zero-G [3]. $300/$15,000.

Nerve Boosters: Replace neural myelin sheaths with synthetic material to speed up nerve impulses. Gives user Increased Speed +1 [25]. Not available as a temp nanomod. –/$125,000.

Pore Cleaners: Clean skin pores and eliminate sweat. $10/$500.

Respirocytes: These function like oxygen-carrying red blood cells, but with many times the transport capability. They store extra oxygen and carbon dioxide, transport it, and release it in intelligent fashion in response to need. They provide Extra Fatigue +2 [6] and Oxygen Storage [14]. $1,000/$50,000.

Tooth Cleaners: These keep the user's teeth clean without any need for brushing or toothpaste. $20/$1,000.

Virus Hunters: These detect and eliminate known viral pathogens, providing Immunity to Disease (Known viruses only, -60%) [4]. $200/$10,000.

PROTEUS NANOVIRUS

These nanomachines enter the body and rewrite the genetic code. Taking control of the cell's metabolism, they can alter the genetic information contained within the DNA, or insert entirely new genes. They can be delivered via injection, aerosol, etc. They take effect after 5d minutes. A HT-6 roll is needed to resist. Bonuses for Disease-Resistant, Guardians, and Panimmunity apply; Immunity to Disease gives +10 HT rather than total resistance.

Many types of proteus virus exist, but they are limited to "soft" changes, whose effects will be seen in altered skin cells or blood cells, modified neurochemistry, and so on. Each proteus virus has a cost and a time (the number of days it takes the nanovirus to finish its work, after the incubation period is over). Some examples:

Birth Control: After onset of first pregnancy, it fools the mother's immune system into attacking developing blastocysts, resulting in undetectable early abortions of second or later children. Subject becomes Sterile (After one child, -75%) [-1]. $500 (and 2 days).

Cosmetic: Different versions alter hair, skin, or eye color, or fix baldness. Subject gains 0-point features, but viral dyes that cure or produce Albinism [-10] also exist. Exotic colors are also possible; e.g., blue skin, metallic nails, or green hair. $200 (and 1 day) for a batch of virus that produces a single cosmetic change; e.g., turn eyes green or hair metallic pink. Multiply the cost and time by the number of features it produces.

Metabolic Reset: Bulk may be altered up or down from Very Fat [-20] to Fat [-10] to Overweight [-5] to normal [0] to Skinny [-5]. Lose or gain one step per 2 days until designated stage is reached. $1,000.

Skin Transformation: Causes subject to sprout thin [0], regular [4], or thick [29] fur ($20,000, 1 week), or very light scales [0] or spiny fur [33] ($40,000, 2 weeks).

The following option can be added to any nanovirus:

Aerosol: The nanovirus can be used in a chemical warhead or aerosol spray. It uses the normal rules for biochemical weapons, affecting anyone who breathes it and fails a HT-6 roll. *×10 price.*

NANOPSYCHOLOGY AND NANOPSYCHIATRY

These are various techniques used to study and manipulate the human mind.

Brainscanning

This uses diagnostic nanomachines in conjunction with HyMRI to create an accurate mental model of the way a person thinks (a "persona map"). The subject must be conscious, but cooperation is not required. Roll against Electronics Operation (Medical) at -2 or Brain Hacking each day to make a brain scan; later updates are performed at +1 and generally take a few hours. Careful study of a recent persona map requires a successful Psychology skill roll and at least two hours. It reveals a person's main mental advantages, disadvantages, and quirks, and gives a +2 bonus to Psychology and +1 to other social skills when dealing with that individual.

Deep Brainscanning: This is an interactive brainscan. The subject must be fitted with both upslink and downslink implants, and parts of the brain associated with memory recall are actively stimulated using nanotherapy techniques. The subject is conscious but in a dreamlike state through most of the process. Roll weekly rather than daily. Success provides data that gives triple the bonus of a brainscan, and which is sufficient to design a shadow.

Brainscanning usually costs $2,500; deep brainscanning costs $10,000.

Psychosurgery ("Nanotherapy")

This uses precisely focused HyMRI fields in conjunction with cellular microsurgeons to selectively obliterate or connect tiny parts of the brain. Before psychosurgery can take place, successful persona mapping is required. Psychosurgery can destroy most mental advantages (e.g., Charisma or Intuition) and any mental disadvantage. It can give someone disadvantages that represent loss of a mental faculty (e.g., Amnesia or No Sense of Humor). It can cure a mental disadvantage that does not represent such a lack; thus, it could "cure" a Delusion but not Weak Will. A cure must be balanced by adding a new disadvantage representing a lack of faculties (or removing an existing advantage) whose point total is worth at least half as much as the disadvantage cured. Thus, you could burn Fanaticism [-15] out of someone's brain, but leave him Confused [-10]. This costs $1,000 times point change (1 day recovery), minimum $10,000. For more extensive rules, see p. BIO71.

RADICAL NANOSURGERY

These procedures involve shutting down a patient's entire metabolism. The patient must be placed in an exowomb (p. 163). Usually, the patient is already in nanostasis or hooked to an ESU (p. 162). In the latter case, nanostasis is initiated prior to immersion in the womb tank.

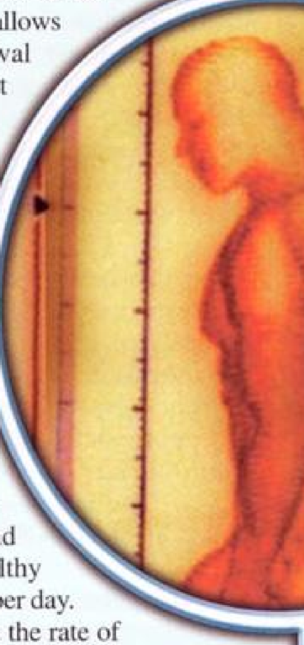
Nanostasis

Nanostasis is a means of safely shutting down a person's metabolism, putting him into a state of suspended animation.

Nanobots place protective scaffolding and fixatives around and within every cell in the patient's body, taking four hours. Two percent of the nanobots used remain in place to act as markers. The rest are removed at the completion of the process, which takes an hour. Organisms in stasis do not require oxygen or food; they cannot age or deteriorate, but are vulnerable to extremes of temperature, radiation, and pressure. These may cause damage to the marker nanobots in the case of radiation, or variously ignite, freeze, pulp, or desiccate the creature being preserved. Nanostasis nanomachines cost $100,000, but since most are recoverable, the typical medical fee is $5,000.

Reversal of nanostasis requires an ESU (p. 162). It takes a day to remove the preservatives, warm the body, and use nanomachines to restart bodily functions.

The procedure is relatively safe, but the subject will be disoriented and confused for hours (sometimes days) afterward. The process supervisor must make a Physician roll. Critical failure means the patient has the Confused disadvantage for 20-HT hours, and has Amnesia (Partial) for at least a week; roll vs. HT weekly to recover. Failure produces the same effects, but roll vs. HT *daily* to regain memory. On a success, Confused lasts only (20-HT)/2 hours and there is no memory loss. Critical success allows immediate recovery. Revival nanomachines cost $200,000, but all are recoverable. The usual medical fee is $2,500 (excluding care while recovering).



Cell Regeneration

The subject must be immersed in an exowomb. Nanomachines permeate the patient's body, instructing and assisting every viable cell in what repairs to make. Nonviable cells are programmed to apoptose (self-destruct), or are removed and replaced with clones of healthy cells. Damage heals at 2 points per day. Radiation damage is repaired at the rate of 20 rads per day. One week is required to treat any diseases present. In 6 weeks, missing limbs and organs can be regrown. The procedure requires $100,000 worth of cell-surgeon nano, 99% of which are recoverable at treatment's end. Usual fee is $5,000 plus $2,500/day.

Cellular Rejuvenation

This is an anti-aging treatment. Proteus viruses reset cellular clocks. Senescent or dying cells are apoptosed and replaced by healthy clones. After six weeks of treatment, the subject's body is restored to young adulthood and full health. All age-related disadvantages and attribute losses are removed. There is a risk of causing irreparable brain damage during the process. Treatment requires $1,000,000 in rejuvenation nano, 95% of which can be reused after the procedure. Usual cost is $450,000.

This procedure is still controversial due to the risk factor involved. Upon the patient's revival, the supervisor must make a Physician roll. Critical failure on this roll results in brain death. Failure means that the patient is Confused for 20-HT hours, and also has Amnesia (Partial); he may roll against HT every week to regain his memory. On a success, the effects are as above, but the patient rolls vs. HT every *day* to regain his memory. On a critical success, the patient is Confused for only (20-HT)/2 hours and suffers no memory loss at all.

Destructive Uploading ("Brainpeeling") and Ghosts

This technology involves the nanodissection of the subject's brain and its recording as digital media. The subject must be placed in nanostasis (p. 166). A cybershell with Micromanipulators 2 (p. 131), such as a bush robot, is required to perform the operation, along with a computer running a Ghost Compiler program (p. 143). Brainpeeling takes 10 hours. Both a Surgery roll at -10 and Computer Programming roll at -5 are required to succeed. Bonuses for Manual Dexterity apply to Surgery, and the rolls can be split between two doctors. A failure on one roll means only a fragment can be created; failure on both, or any critical failure, means the upload fails completely. Regardless, only *one* try is possible: brainpeeling kills the subject and destroys his brain!

Ghosts: A mind emulation based on this data has the original's DX and IQ, any strictly mental advantages, disadvantages, or quirks, and all skills. It has full memory and personality. Refer to the *Ghost* template on p. 120 for other advantages and disadvantages.

Fragments: As above, but points the original put into mental skills are halved and points in physical skills are divided by 4 (round fractions smaller than 1/2 down to 0), reducing levels accordingly. It will suffer Amnesia (Partial) [-10]. Refer to the *Fragment* template on p. 120 for other advantages and disadvantages.

Uploading the Dead: It is possible to upload a dead person's mind and retrieve a ghost or fragment, as long as the brain is intact. This is at the GM's option, but total destruction (-10 × HT), 5,000+ rads, or death from damage to the brain usually precludes uploading. Deep structures containing long-term memories may survive for a few hours after death, but not indefinitely. Rolls are at a -2 for any corpse, with an additional -1 penalty per hour past death unless preserved via cryonics or nanostasis. A corpse preserved via cryonics has an extra -3, however, due to cell damage from freezing. Memories from the last 1d × 20 minutes before the person died will often be lost in the uploading process. This means that someone who is revived via uploading will often have no memory of the last moments of his life.

Xoxing: Once an upload is made, it can be copied any number of times. No skill roll is required to do this.

MICROBOT SWARMS

"We Marines believe in close air support. Since the USAF is usually too busy to visit Earth, the Corps has assigned each of you your own personal air force. That gadget bolted onto the back of your M-70 armor is the M-823 ***Apshai*** *personal-defense hive. It houses four Nanodynamics microbot cyberswarms, radiothermal-generator powered, with mission-tailored equipment packages. The repair and medical swarms will fix up you and your suit, with the hive having ducted access to your suit interior. The explorers are expendable recon assets whose utilization you should maximize in built-up areas. The devourers provide close protection against hostile swarms, and an antipersonnel capability against anyone stupid enough to close with you. Trust your swarmies like your brothers. They are a gestalt intelligence composed of 4,000 tiny little buddies programmed to do just one thing: look after your sorry butts."*

– Gunnery Sergeant Juanita Rodriguez-Martello, USMC, 2090

Microbots are insect- to microbe-sized robots with microscopic components. None of them are individually intelligent. Because they are so small, they are treated as groups rather than as individuals. They are controlled by pinhead-sized or smaller computers running simple programs modeled on insect behavior patterns. A colony of such robots has intelligence superior to that of any component part, just as an ant colony is an extremely adaptive organism, while each ant is amazingly stupid.

A group of microbots is called a cyberswarm. A cyberswarm consists of hundreds or thousands of microbots programmed to act in concert. They follow simple, preprogrammed behavior, moving in a specified pattern to perform their tasks and then (if so programmed) return to base. Individual microbots are rarely larger than fleas, so it is most convenient to measure cyberswarms in hexes. A typical swarm is 1 hex in size, but swarms can be larger. Up to 10 swarms can effectively "stack" in a hex; a dense swarm can be more effective.

The procedure to design a cyberswarm is simple: select a swarm size (in hexes) and chassis, then choose an equipment package. This will determine the swarm's cost and capabilities.

Swarm Statistics

A one-hex cyberswarm weighs one pound. It has ST 1, DX 10, IQ 4, and HT 12, with 12 hit points. Its skill at any task it is equipped for (see *Microbot Equipment Packages,* pp. 169-171) is equal to its *current* hit points (to a maximum of 12 for multi-hex swarms), while its IQ is equal to its *current* hit points/3, rounded down (but no higher than 4). As it is effectively a hive intelligence, the more damage the swarm takes, the stupider it gets!

Chassis

The chassis provides the basic body, motive system, sensors, and brain. Select the chassis for the cyberswarm and calculate its cost. All costs are per hex of swarm; for swarms larger than 1 hex, multiply by the number of hexes.

Aerostat: A tiny, lighter-than-air balloon with an air turbine. Move 2 (flying in air). $3,500.

Armored Crawler: Similar to the crawler (below), but with a tougher shell. Armored crawlers can survive corrosive atmospheres or high pressures (such as on Venus). Move 2 (on the ground). $6,500.

Crawler: Each microbot vaguely resembles a tiny, metallic ant or beetle, or a miniature tracked vehicle. Move 3 (on the ground) or 1 (swimming). $2,500.

Dust: The swarm resembles a cloud of dust motes unless examined using Microscopic Vision, bughunters (p. 169), or a chemscanner. Dust swarms are tinier than other cyberswarms, but lack mobility. The only equipment package they may have is Surveillance (p. 170). $600.

Flyer: This looks like a tiny helicopter, or a mechanical wasp or bee. Move 8 (flying in air) or 2 (on the ground). $10,500.

Hopper: Each microbot vaguely resembles a tiny, metallic flea or cricket, with long rear legs. Move 4 (straight-line hopping movement) or 3 (on the ground). $2,500.

Space: The swarm can link together to function as a solar sail, accelerating at up to 0.0001 G within the inner solar system. It can also crawl on the ground at Move 2. $10,500.

Swimmer: These microbots resemble tiny robot submarines, tadpoles, or water insects with teeth and arms. Move 4 (swimming). $2,500.

Toy: The microbots resemble miniature toy humans, animals, etc. They are generally restricted in their operating radius and limited to Move 1. The only equipment package they may have is Play (p. 170). $500.

Disguise

Most cyberswarms can be disguised as a swarm of real animals (typically insects) of similar size and shape. This costs an extra $1,000/hex. Aerostats cannot be disguised. Space disguise is only effective when crawling. As well, any swarm can have a chameleon system (p. 186) for $500/hex. A disguised swarm's true identity can be determined if it takes damage. An RTG-powered swarm also shows up on radiation detectors.

Power Supply

The default power system is batteries. These power the swarm for 3 hours of operation or mobility. A swarm that isn't doing anything, or a space swarm that is flying, consumes minimal power. For flyers only, 1 hour of flight consumes as much power as 2 hours of crawling (a flyer swarm can conserve power by crawling). The swarm can recharge by entering a cyberswarm hive (see p. 142) and hooking up to an attached power supply; recharging the entire swarm requires 0.025 kWh of energy per hour of operating time. Alternatives include:

Gastrobot: These "live off the land" while performing their duties. They will eat about as much as a similar-sized swarm of insects. They breathe air, and cannot survive in vacuum or very low pressures. Add $2,000 to cost.

RTG: The microbots have miniscule radiothermal generators. These use tiny amounts of radioactive material, the decay of which releases energy enough to power the microbot for 1 year. These can be detected by Geiger counters. Add $3,500 to cost. LC 3.

Solar Cell: The microbots have small solar panels built into their bodies or wings, in addition to batteries. In bright light, they can recharge energy sufficient for 30 minutes of operating time for each hour they remain dormant. Add $1,500 to cost.

Microbot Equipment Packages

A cyberswarm's function depends on the specialized tools, manipulators, programming, and sensors of its constituent microbots. (A swarm with a given function might actually represent several different types of microbots working together.) A swarm may normally have only *one* of the following packages, with the exception of functions that explicitly note that they can be combined with other functions. All costs are per hex of swarm; for swarms larger than 1 hex, multiply by the number of hexes.

Bughunter: These microbots contain emissions sensors (treat as Field Sense advantage, p. CI55). Each hex of bughunters can sweep one hex per minute to locate surveillance devices, hidden microbots, or similar devices. They have Electronics Operation (Security Systems)-12 for this function only. $4,000.

Cannibal: The microbots are preprogrammed to cannibalize other objects to build a single, specific gadget, using their own bodies as component parts. They must first find an object that contains raw materials suitable for the task. Creating mechanical devices (guns, engines) requires objects made of metal. Plastics often are broken down to make gas, propellants, etc. Creating electronic devices requires cannibalizing other electronic systems; any such device in the area takes damage as per a devourer swarm (p. 170). Whatever is cannibalized is destroyed (or, rather, transformed). Assembly takes 1 minute per pound of gadget weight, divided by the size of the swarm in hexes. Whether the process works depends on the suitability of the available material. The process produces residual heat, so it is best to employ it on a non-flammable surface (such as a concrete floor) and turn off smoke detectors. Each cannibal swarm is specific to one gadget or weapon (but a swarm may build several, closely related gadgets as long as they can all be fused into one object; e.g., a gun with a laser sight, a helmet with built-in infrared goggles, or a cybershell). The maximum weight of the gadget is 10 lbs. per hex of the swarm. Cost of the swarm is 15 times that of the intended gadget or $15,000/hex, whichever is *more.* Cannibal swarms are LC 1 or the LC of whatever they build, whichever is lower.

Cleaning: The swarm is programmed to move around a predetermined area, removing dust and grit, and polishing smooth surfaces with tiny brushes. Their sensors determine when material might be damaged by their actions; they can safely polish lenses, and even harmlessly clean people! Each hex of swarm can thoroughly clean a one-hex area every minute. This is among the most common of cyberswarms; some large spacecraft and buildings have permanent colonies of solar-powered cleaning swarms to polish windows, viewports, and sensor lenses. $1,000.

Construction: The cyberswarm is designed to tunnel, dig ditches, etc. It is equipped with small arms and digging jaws. Each hex of swarm can dig as if it had ST 3 (rather than ST 1) and a pick and shovel (see p. B90). They are often employed for mining, or civil or military engineering. They can also pile up loose earth, rock, etc. into ramparts, dikes, or walls. $1,000.

Decontamination: Removes traces of most biotoxins, persistent chemicals, radioactive fallout, etc. Each hex of swarm can decontaminate a one-hex area every minute. A hex of swarm can decontaminate a 10-hex area before requiring replacement. $1,000.

Defoliator: This swarm kills foliage within its hex, but has no effect on other living creatures. It takes the swarm 10 seconds to strip a hex clean of bushes or foliage. It can also be programmed to carefully trim plants; this takes one minute per hex. It may be programmed to affect specific plants (for example, weeds) or to mow lawns. $1,500.

Devourer: These microbots have small, diamond jaws; a swarm of hundreds of such robots can chew through almost any barrier or armor, given time. Any target, organic or machine, caught in a devourer cyberswarm takes 1d+3 points of damage per turn. DR protects normally if it covers the entire body, but a cyberswarm that cannot penetrate armor will destroy 1 point of armor DR every turn! If multiple hexes of swarm condense into the same hex, DR reduction is cumulative. $8,000. LC 1.

Explorer: The swarm is programmed to probe in a spiral pattern, using contact sensors to take minute chemical samples of materials encountered. Explorers may be programmed to look for particular mineral or chemical traces, explosives, water, organic molecules, etc. After a predetermined search pattern, the swarm is programmed to deposit its samples in an automated analysis hive (p. 142) that collects and chemically analyzes them. The hive can process one hex of swarm samples per minute. By analyzing where and when the swarm found items or encountered impassable barriers (such as water, if the swarm cannot swim or fly), the hive's dedicated computer can build up a map of the area explored. $500.

Forensic: This can gather forensic evidence, sweeping one hex per hour. Forensic microbots can gather vast amounts of data, analyzing organic and inorganic detritus: skin flakes, blood, clothing fibers, food residue, etc. A forensic swarm can also *clean up* evidence at the same speed. $4,000. LC 4.

Gremlin: The swarm is equipped with tiny drills, cutters, and the like, and is programmed to crawl inside electronic or mechanical devices and jam up the works, slice through wires, eat circuits, etc. Only sealed machinery or electronics, or devices lacking small moving parts, are safe. Each hex does 1 point of damage/turn to unsealed machinery, ignoring armor DR; machinery acquires a Malf of 17, with an extra -1 each time it loses 10% of its HT. Damage caused by gremlins doesn't physically destroy an object, but is treated like other damage for repair purposes, etc. For non-weapon devices, check for malfunction when they are turned on and each minute they are in use. Sabotage is not immediately obvious. $2,000. LC 1.

Harvester: These can harvest crops with an effective Agronomy skill of 12. $2,000.

Hypo: As Stinger, but with the user's drug of choice. Anyone who takes damage must make the necessary rolls to avoid the effects of the drug. $2,000, plus the cost of 10 doses of the drug. LC 3.

Illumination: The microbots glow in the dark, illuminating the area they occupy. Illumination level can be varied from a soft glow to bright enough to read by. This can be combined with any other system. $100.

Painter: Similar to Cleaning (p. 169), but programmed to spread paint or ink around. Simply upload a particular design, provide paint, and they will go to work. Each hex of microbots can paint 1 hex per minute, and paint up to 2 hexes before requiring paint refills. $500.

Paramedic: A paramedic swarm is composed of a variety of individual microbot subtypes. Some taste blood and perform diagnosis; some cut away damaged tissue, clean wounds, sew up cuts, and inject drugs; and some enter the body to perform internal repairs or diagnosis. First, the swarm stops the patient's bleeding. Then it performs first aid (takes 30 minutes), cleaning and repairing damaged tissue. Each hex can treat one person at a time. Has Diagnosis-12 and First Aid-12. $6,000.

Pesticide: The swarm is equipped to hunt down and eliminate fleas, spiders, and other pests. Flyer swarms can also engage and destroy flies and mosquitoes. They will inflict 1d damage per turn to swarms composed of ordinary or gengineered insects. The microbots' actions are harmless to humans, although they can be entertaining or distracting. $1,000.

Play: The microbots play and interact with one another in an amusing fashion. For example, a "farm in a box" might contain microbots that look and act like tiny animals, agricultural robots, human farmers, etc. $100-$1,000.

Pollinator: The swarm functions as artificial bees, spreading pollen or seeds. This is useful if normal insects are not available, or cannot adapt to the local climate or ecology. $1,000.

Repair: The swarm has the tools and programming to repair a single, specific model of equipment, plus appropriate Armoury, Electronics Operation, or Mechanic skills at 12. A single swarm fixes things at about one-tenth the speed of a human, but up to 10 swarms can combine to make repairs at a progressively faster rate. The package costs $500, plus $250 per additional model of equipment the microbots are programmed to fix, to a maximum of four types of equipment per swarm.

Sensor Array: Each microbot in the swarm mounts an infrared sensor and a lasercom. They coordinate to form a synthetic-aperture infrared sensor array (treat as Infravision). Effective range is 1/2 mile per hex of swarm (5 miles/hex in space); all hexes must be adjacent to one another, with no more than one swarm per hex. The swarm will normally remain stationary or follow a particular individual, and is programmed to upload imagery to him. This function is only available for aerostat, space, or flyer swarms. $2,000.

Sentry: These microbots are equipped with weapons optimized for combating other microbots. Each hex inflicts 2d damage per turn on other microbot swarms. $5,000.

Stinger: These microbots have tiny jaws or stinging needles. The swarm does 1 point of damage per turn to living beings (only) in contact with it, unless they are completely covered in sealed armor. $1,500. LC 2.

Surveillance: These microbots mount tiny video cameras, collectively equivalent to a larger nanobug (see *Nanobug,* p. 154). The swarm is normally programmed to remain in a particular place, observe for a period of time, and then return; it can also transmit information or be ordered to go to a different location if precise coordinates are given. $100. LC 5.

Swarmwear: This can be combined with any other microbot function. It preprograms the microbots to hover in close formation around a person, forming a body suit, a trailing cloak, or a veil and cloak. The swarm will not cover the user's eyes or mouth unless commanded to do so. It does not interfere with movement: the swarm tracks the user's body with its sensors and adjusts to his motion. Up to 4 hexes can combine around a person. Swarmwear is monochromatic, but chameleon microbots can change to multiple colors or patterns if desired. A 1-hex swarm is somewhat wispy; a 2-hex or denser swarm is opaque. Swarmwear microbots can only act upon the user or anyone touching him. A swarmclad person has DR 0.5 per hex of microbots surrounding him, divided by his size in hexes (round down). The swarm does not affect the wearer's PD. This function is only available for aerostat swarms. $500.

Terminator: As Stinger, but with especially virulent nerve poison. Anyone who takes damage must make a HT roll one minute after being hit, with a penalty equal to the cumulative damage of the stingers. A success means only 1d damage is taken; a failed roll means total paralysis and 2d damage per hour until the victim dies or receives an antidote. Each hex of swarm can make up to 10 attacks before requiring extra poison (treat as 10 doses of nerve poison). $4,000. LC 1.

Finishing Up

Record the swarm's Move, endurance in hours, hit points, and any damage it inflicts. Come up with a name for the cyberswarm (e.g., "Xenotech Biocide Mk. 2").

Cyberswarms in Action

A cyberswarm can take orders via datalink from any computer; swarms are equipped to send and receive radio, laser, or infrared signals, with a range of about 0.01 mile for infrared or laser and 0.1 mile for radio. The operator must know the access codes for that particular swarm. Orders are limited to actions related to the swarm's equipment package, to movement, or to recharging.

Sense Rolls: If a cyberswarm has to make a roll to notice something, use the lower of its original HT or its current hit points as its generic sense roll.

Multiple Swarms: Multiple friendly swarms can work together, but cyberswarms generally avoid "stacking" unless commanded to do so.

Attacks: Microbots with the Devourer, Hypo, Sentry, Stinger, or Terminator functions may make attacks. Normally, they attack any entity they come upon while moving through a preprogrammed path; this makes them most useful when programmed to "sterilize" an area or to sweep a security perimeter. Swarms may also be programmed to differentiate by species or even by sex, using sophisticated chemical sensors (this has no effect if the target is in airtight armor). When the swarm comes within a preset distance (up to its current hit points in hexes) of a permissible target, it will move to attack. Use the *Swarm Attacks* rule on p. B143. The effects depend on the swarm's equipment package.

Attacking a Swarm: Use the *Attacking a Swarm* rule on p. B143, but torches and flaming weapons do only 1 hit to armored crawler, crawler, hopper, or swimmer swarms. (Aerostat, dust, flyer, space, and toy swarms are more vulnerable.) Damage is applied to each hex of the swarm; when it equals or exceeds the cyberswarm's hit points, the swarm is effectively destroyed. Lesser damage also has an effect, reducing the swarm's effective skill and IQ as described on p. 168.

Damage to Swarms: Vacuum, gas, poison, and non-corrosive atmospheres have no effect on cyberswarms other than gastrobots. Most high-tech and ultra-tech weapons inflict only 1 hit per attack. However, any weapon that affects a wide area (such as a shotgun or the concussion damage from an explosion) does full damage to airborne aerostats or flyers, or to a space swarm. It does half damage to crawlers, swimmers, or grounded flyers, and only one-third damage to armored crawlers. Electrolasers also inflict full damage. The Devourer and Sentry functions allow swarms to attack other cyberswarms, doing full damage each turn.

Insect Bioswarms

These are swarms of genemod insects. Treat them as microbot swarms with crawler, flyer, hopper, or swimmer chassis and gastrobot power, but at 10% cost. The only "equipment packages" they may have are Construction, Defoliator, Harvester, Pesticide, Pollinator, or Stinger. They take damage as per p. B143, and are vulnerable to gases and unbreathable atmospheres, but take no special damage from electrolasers. They live for about 6 months. Ranged control is not possible: they must be given orders from a special insect director device that uses pheromone signals to communicate with them. It takes 30 seconds to give a new set of orders. Orders are limited to one very specific set of commands within the nature of their function package; e.g., "harvest that field" or "head north until sunrise and attack anyone in the way."

Insect Director: Range 1 yard. $2,000, 0.25 lb. A computer with an insect director program (Complexity 4, $100, specific by type) is also required.

TRANSPORTATION

Adventures often take place in interesting or dangerous locales – but first you have to get there. The journey itself can be part of the adventure.

Ground Travel

On Earth, external traffic-control computers control the majority of city and highway traffic (except emergency and security vehicles). Cars, buses, and trucks drive themselves, and most buses and taxis, and nearly all trucks, are robotic. Driving skill is dying out in Fourth and Fifth Wave nations.

Most offworld colonies have few roads outside major centers. Vehicles are sealed for life support and often powered by batteries or fuel cells. Many are sturdy off-road designs with giant tires or tracks for traversing rough terrain.

Railways are common on Earth, Luna, and Mars. Thanks to cheaper superconductors and fusion power, magnetic-levitation trains that move at 200-300 mph are common. Train tickets are $5 per 100 miles; city subway passes are $1/ride.

Air Travel

On Earth, most commuter and private aircraft are wingless, ducted-fan VTOL (vertical take off and landing) "air cars" and "air buses" that carry up to 40 passengers at 300-600 mph. Air taxis are $10/minute. Flights over 200 miles are usually aboard sleek, swept-wing transonic jets, which supercruise at 700-800 mph and have smart-matter airframes that can ripple or subtly alter shape to control flight. Tickets cost about $200 + ($0.1/mile). Travelers in a hurry may fly from major airports in transatmospheric rocket planes, which can carry 10-50 passengers at speeds over 4,000 mph for about $2,000 per trip.

Light aircraft are used *inside* big space colonies like Islandia. Fixed-wing airplanes and airships are common on Mars and Titan.

Maritime Travel

Large cargo ships remain in use on Earth, many completely automated. Except for ferries, most water travel is for pleasure or sport. Private submarine yachts are affordable for the wealthy, and a few fusion-powered cruise-submarines also exist. Maritime craft are also used on Mars, Europa, and Titan.

Space Passage

Trips from a planet's or moon's surface to orbit normally use single-stage spacecraft, often with laser-rocket propulsion. The basic fare for a surface-to-low-orbit trip is $5,000 per person or $10,000 per ton of cargo, multiplied by the body's "to orbit" velocity in mps (4.9 for Earth). Thus, a passenger ticket from Earth to LEO is $24,500. Orbit-to-surface costs are identical if the planet has a trace or vacuum atmosphere (like Mercury or Luna), half as much otherwise. Thus, it's $12,250 from LEO to Earth. Multiply costs by 1.5 for trips to or from HEO, or by 2 for GEO. In practice, most spacecraft dock at a LEO station and then refuel, or transfer cargo to cheaper, unstreamlined vehicles.

Near Space Passage: Voyages from space stations to other stations (or microgravity moons or asteroids) within 1,000,000 miles (about 0.01 AU) are classed as "near space voyages." This would include a trip from Earth orbit to lunar orbit or L4/L5, for example. The usual spacecraft is an orbital transfer vehicle (p. 74). Passengers are seated and flight time is a few hours. Costs range from about $500 for a short hop between nearby space stations to about $2,500 for a longer trip (such as Earth orbit to lunar orbit or L4).

Deep Space Passage: These fares apply to voyages over distances greater than 0.01 AU, such as between planets, distant gas-giant moons, or asteroids. A typical vessel is a *Meizi*-class PSV or *Sudbury*-class USV. An economy-class fare is $3,000/AU if the cabin is shared, $6,000/AU alone. A first-class trip (with a luxury cabin and superior service) is $6,000/AU each if a couple shares a cabin, otherwise $12,000/AU. Treat distances less than 1 AU as 1 AU.

Space Freight: An average price is $1,000 per ton of mass or 100 cubic feet of volume (whichever is more) per AU or fraction thereof (i.e., $5,000 per space of cargo). A typical carrier for interplanetary cargo is a *Sudbury*-class USV, although larger vessels are used when carrying very bulky or heavy cargoes.

Nanostasis: An alternative to normal passenger travel is nanostasis (p. 166). With a sealed storage unit, this is 0.5 ton of cargo per person. Cost of nanostasis and revival is *not* included.

Charter: A chartered flight costs about 0.1% of the vessel's price per day of travel, plus crew salaries and expenses. As a rule, only USV-class spacecraft are available.

Flight Time: This depends on the vessel used; see Appendix B.

APPENDIX A: SPACECRAFT DESIGN

> *"It is the policy of the United States Aerospace Force to neither confirm nor deny the presence of nuclear weapons aboard deep space vessels."*
>
> *– USAF Deep Space Command*

> *"Usual armament of the DFS-3* **Angel** *is estimated as four* **Predator** *autonomous kill vehicles, whose 333mm coilguns are loaded with either SGM-83* **Mjolnir** *kinetic-kill weapons or SSM-96* **Excalibur** *nuclear bomb-pumped X-ray laser submunitions."*
>
> *– Jane's Fighting Spacecraft, 2099*

Thousands of space vessels operate in the solar system, ranging from plasma-sail slowhaulers to lethal space dominance vehicles. This appendix provides the rules for designing space vessels of various types, including space stations and satellites.

HULL DESIGN

The hull is the frame of the vessel, including armor, decks, and stress bracing. Hulls are usually constructed in microgravity spaceyards, with the exception of transatmospheric craft.

HULL SHAPE

A hull may be a box, cylinder, sphere, streamlined cylinder, streamlined delta, or torus (a donut-shaped ring). Spheres are the easiest to design. Most spacecraft are cylinders, spheres, streamlined cylinders, or streamlined deltas. Most space stations are cylinders, spheres, or tori.

Decide on the hull's shape, then refer to the entries below to find its dimensions (in feet), volume (in *spaces* of 500 cubic feet), and surface area (in ksf, or thousands of square feet).

A spacecraft may be constructed from a combination of shapes, but this adds complexity; see *Combination Manufactured Hulls* (p. 175).

A vessel must be streamlined to boost into space from a world with a very thin or denser atmosphere.

The cost and mass of landing gear are included in the statistics for the hull. If the vessel is streamlined, then the landing gear is assumed to be retractable; unstreamlined vessels typically do not have retractable landing gear.

Sphere

Dimensions: Select the diameter of the hull in feet (at least 5 feet). Radius (R) is half diameter.

Volume: Spaces = $R^3 \times 0.008$.

Surface Area: Total Area (ksf) = $R^2/80$.

Example: A 10'-diameter sphere has 1 space and Total Area 0.3125 ksf. A 100'-diameter sphere has 1,000 spaces and Total Area 31.25 ksf. A 600'-diameter sphere has 216,000 spaces and Total Area 1,125 ksf.

Cylinder and Streamlined Cylinder

Dimensions: Select the length of the hull (L) and its width (W). Length should be at least 10 feet and width at least 5 feet. The cylinder's length can be anywhere from 1 to 20 times its width; if it is streamlined, then its length should be at least 3 times its width.

Volume: Spaces = $L \times W^2 \times 0.0016$.

Surface Area: Side Area (ksf) = $L \times W \times 0.0032$. Back Area (ksf) = $W^2 \times 0.0008$. Front Area equals Back Area, but multiply by 1.4 if streamlined. Total Area = Front Area + Back Area + Side Area.

Example: A 50'-wide cylinder has 200 spaces per 50' length; Front/Back Areas are 2 ksf each; Side Area is 8 ksf per 50' length.

Streamlined Delta

Dimensions: Select the length of the hull (L), which should be at least 10 feet. Width is $0.6 \times L$; height is $0.3 \times L$.

Volume: Spaces = $(L/25)^3$.

Surface Area: Total Area (ksf) = $(L/25)^2 \times 0.5$.

Example: A 125' long delta has 125 spaces and Total Area 12.5 ksf.

Box

Dimensions: Select the length (L), width (W), and height (H). Length should be at least 10 feet, and width and height at least 5 feet and not less than 5% of length.

Volume: Spaces = $L \times W \times H \times 0.002$.

Surface Area: Side Area (ksf) = $[(L \times H) + (L \times W)] \times 0.002$. Back Area (ksf) = $W \times H \times 0.001$ ksf. Front Area equals Back Area. Total Area = Side Area + Back Area + Front Area.

Example: A box 50' in all dimensions has 250 spaces, Side Area 10 ksf, Front/Back Areas 2.5 ksf each, and Total Area 15 ksf.

Torus

Dimensions: Pick the mean torus radius (R) and the cross-sectional radius (r) in feet. If the torus is imagined as a donut lying flat, mean torus radius is the distance from halfway between the outer edge and inner edge to the center of the hole, while cross-sectional radius is half its height. Diameter is twice radius. The torus should have a minimum torus radius (R) of 5 feet, with the cross-section radius (r) no more than half R. A 300' radius or larger torus can be spun at a comfortable rate to give Earthlike gravity.

Volume: Spaces = $R \times r^2 \times 0.04$.

Surface Area: Total Area (ksf) = $R \times r \times 0.04$.

Example: A torus with 300' radius and 50' cross-section radius has 30,000 spaces and Total Area 600 ksf.

MANUFACTURED HULL OR ASTEROID HULL?

Decide whether the vessel has a manufactured hull or an asteroid hull. A manufactured hull can be any shape; an asteroid hull must be either a sphere, or a cylinder without streamlining and no more than twice as long as it is wide. If the vessel has a manufactured hull, determine its characteristics per *Manufactured Hulls* (below). If it uses an asteroid hull, refer to *Asteroid Hulls* (p. 175).

MANUFACTURED HULLS

A hull may be made of metal alloy, composites, or exotic nanofactured materials. Metal hulls are often manufactured in space using evaporation guns, which direct a conical hot molecular beam at a balloon-like form. The form is rotated under the beam to build up a hull of the desired strength and thickness.

Materials are listed below in order of ascending cost and decreasing weight for a given toughness. Pick one hull material for the *structural frame* and one as *armor* (these need not be the same). Light, expensive materials can be vital for transatmospheric spacecraft, but heavier materials offer more radiation shielding for the same cost, making them attractive for space habitats.

Slag: Leftovers from processing lunar ore and asteroid material. It may *not* be used for the structural frame, but may be used as armor. It is usually too heavy to be a sensible choice for spacecraft, but is often used by space stations.

Steel Alloy: Steel is readily manufactured from asteroids in space, so many large habitats use it. Large steel hulls may also be constructed via the Cole technique (p. 39).

Aluminum Alloy: An aerospace-grade aluminum-lithium alloy. Most aluminum used in space is mined on Luna, where it is fairly abundant.

Titanium Alloy: A low-cost, aerospace-grade titanium-aluminum alloy.

Foamed Alloy: An aluminum-lithium alloy in which zero-gravity manufacturing techniques have created evenly distributed foamed air pockets, reducing weight while retaining structural strength.

Carbon Composites: Advanced carbon or polymer composite materials.

Metal-Matrix Composite (MMC): Metal particulates or whiskers are embedded in another metal. Examples are boron-aluminum or, at higher cDR values, titanium-silicon carbide.

Nanocomposite: This nanofactured material is a carbon nanotube-reinforced polymer composite with a ceramic coating.

Diamondoid: This is a nanofactured synthetic diamond composite. It is expected to become cheaper if and when nanoassembler technology matures.

Manufactured Hull cDR

All spacecraft are armored. Armor is rated for its Damage Resistance (DR) in cDR (cDR 1 = DR 100). A station or deep-space vessel requires cDR 1 for minimal protection against micrometeorites and radiation; military vessels and permanent habitats often have much higher values. Unmanned spacecraft, or those designed for ground-to-orbit operations, may have fractional cDR values; minimum cDR is 0.2.

Choose the cDR of your vessel. A high cDR makes a vessel heavier, slower, and more expensive, but more conducive to survival. A cylinder or box may have different cDR values for its Front Area, Back Area, and Side Area. If so, assign cDR and calculate armor mass and cost using individual areas rather than Total Area.

Manufactured Hull Frame Strength

Choose a frame strength. Some modern deep-space vessels have a robust *extra-heavy* frame for maximum structural strength. However, vessels may also be more lightly built, sacrificing robustness for performance; such vessels have *heavy, medium,* or *light* frames instead. Most space stations have light frames.

Manufactured Hull Options

Decide whether your vessel will have any of these options:

Responsive: A responsive hull's skin incorporates micro- and nano-mechanisms that alter hull shape in response to aerodynamic stresses. This is primarily useful for spacecraft that will also operate in atmosphere. Only available for vessels whose structure *and* armor are diamondoid, nanocomposite, metal-matrix composite, or carbon-composite.

Smart: The hull incorporates micro-robotic sensors and processors, allowing quick self-diagnosis of structural damage and stress. Only available for vessels whose structure *and* armor are diamondoid, nanocomposite, metal-matrix composite, or carbon-composite.

Lifting Body: A streamlined delta (only) can have its hull optimized to produce extra lift in atmosphere.

Manufactured Hull Mass and Cost

Next, calculate the hull's structural and armor mass and cost based on the hull's materials, using the formulae below and the values *M* and *C* on the *Materials Table.*

Structural Mass: Structural Mass (tons) = M × Hull Spaces/F, where *M* is the *Materials Table* value for the chosen structural material and *F* depends on frame: 10 if extra-heavy, 15 if heavy, 20 if medium, 40 if light.

MATERIALS TABLE

Material	M	C
Slag	100	$0.00005
Steel Alloy	25	$0.001
Aluminum Alloy	20	$0.002
Titanium Alloy	15	$0.003
Foamed Alloy	12.5	$0.004
Carbon Composite	7.5	$0.02
Metal-Matrix Composite	5	$0.06
Nanocomposite	3	$0.2
Diamondoid	2	$1

Structural Cost: Structural Cost (M$) = Structural Mass × C, where *C* is the *Materials Table* value for the chosen structural material. Other multipliers (multiply them together): ×1.5 if responsive, ×2 if smart, ×1.2 if lifting body, ×10 if streamlined delta or streamlined cylinder.

Armor Mass: After deciding on the hull's cDR, calculate the armor's mass as follows: Armor Mass (tons) = Total Area × cDR × M, where *M* is the *Materials Table* value for the chosen armor material.

Armor Cost: Calculate the armor's cost using this formula: Armor Cost (M$) = Armor Mass × C, where *C* is the *Materials Table* value for the chosen armor material.

Combination Manufactured Hulls

Some manufactured vessels are composed of multiple shapes. This adds complexity, but is useful when designing certain types of spacecraft. For example, a vessel might have a sphere as the front hull, a narrow cylinder as the main hull, and a wide cylinder as the rear hull. If so, record the way in which the hulls are connected. A sphere may connect to a cylinder or box of smaller width, and a cylinder or box to another of any width. A torus may have a smaller cylinder, box, or sphere in its center, connected by two or more narrow cylinders or boxes (the "spokes").

Design each individual "hull" normally. Then calculate the combined surface area by adding together the Total Area of each hull. Whenever a cylinder connects with another hull of equal or greater diameter, subtract the cylinder's appropriate cap area from the area of the hull section it connects to.

ASTEROID HULLS

An asteroid hull may be created from either ice or rock.

Ice Hull: These were originally comets, Kuiper Belt objects, or chunks of ring ice. An artificial ice asteroid can also be created in space by filling an inflatable shell of the desired shape with water, then placing it in shadow to freeze it. Ice hulls are often manufactured at Main Belt, Trojan, and Saturnian spaceyards. They are heavy and bulky, but give good protection against radiation and lasers, and can be used as extra reaction mass for fission drives, fusion torches, and mass driver engines. Ice can melt, so these spacecraft usually do not stray within the orbit of Venus! Throwaway ice-hulled spacecraft are often created by Gypsy Angel and Martian ice miners who attach mass drivers and control systems to Kuiper Belt objects for "crash terraforming" Mars.

Rock Hull: These are carbonaceous or stony-iron asteroids that have been partially tunneled out. This "beehive" technique is simpler than melting and reforming a metal asteroid via the Cole technique (p. 39), resulting in a heavier and bulkier, but cheaper, spacecraft. Permanent rock-hulled space habitats are common. Rock-hulled spacecraft are usually propelled by mass drivers.

Asteroid Hull Waste Space

Some of an asteroid hull's internal space is simply rock or ice. Select the number of rock or ice spaces in the hull (at least 10% of total space). The more rock or ice, the cheaper and heavier the hull will be (as that ice or rock is not tunneled out) but the tougher it will be as well. Habitats built into large asteroids or comets are often 50% or more rock or ice. With appropriate processing equipment, rock spaces can be used as reaction mass by mass drivers; ice spaces are usable in mass drivers and in fission and fusion drives.

Asteroid Hull Mass, Cost, and cDR

Hull Mass: Hull Mass (tons) = W × T, where *W* is the number of waste spaces in the hull, and *T* is 26 if rock, 14 if ice.

Hull Cost: This depends on how much rock or ice had to be tunneled out, rather than how heavy the hull is. It's easier to tunnel through ice than rock, so ice hulls are cheaper. Hull Cost (M$) = (Hull Spaces - Waste Space)/C, where *C* is 10,000 if rock or 50,000 if ice.

cDR: cDR = Hull Mass/(M × Total Area), where *M* is 170 if rock or 230 if ice. Round to nearest 0.1 cDR.

GRAVITY GENERATION

Space is a zero-G environment, but most humans are physically and mentally accustomed to life in a gravity field. Due to the expanding spacer population of micro-gravity-adapted parahumans and bioroids, more and more crewed space vessels are being built *without* gravity generation. Nevertheless, many vessels are still designed to produce artificial gravity.

The only way to produce real gravity is with mass. This means that to produce Earth-equivalent gravity, a space vessel requires an Earth-like mass, which is not very practical. Instead, vessels accelerate or spin to simulate gravity.

A spacecraft under acceleration will produce effective gravity equal to its sAccel rating; so if a vessel is accelerating at 0.16 G, its inhabitants will experience the same gravity as on Luna. Unfortunately, spacecraft cannot usually sustain high accelerations for more than a few hours. The alternative is *spin gravity.*

Spin gravity simulates gravity through centrifugal force. However, the spin cannot be too fast or it will induce motion sickness and structural stress. Spin gravity can be provided in various ways: a spinning hull and spin capsules are the most common. Gravity depends on the *spin radius,* which varies depending on the mechanism used (see below). At a tolerable spin rate, the *maximum* simulated gravity (G) equals spin radius (in feet) divided by 300; a reduced gravity can be selected by using a slower rotation rate. A spin radius of triple this (maximum G = radius/1,000) is usual for large space stations, to ensure that no one experiences motion sickness.

Spinning Hull: A torus, sphere, or cylinder can be spun – via external assistance for a space station, or by thrusters for a spacecraft. This gives a spin radius equal to half the width of the hull (cylinder or sphere) or the mean radius (torus). Going partway to the center of rotation (and also away from the equator, in a sphere) reduces gravity proportionally; for this reason, a vessel's living quarters are usually located where gravity is closest to the home gravity of the occupants. Calculate the spin gravity as shown above. For example, the space factory *Chien 57* is a cylinder 1,000' long and 500' wide, for a spin radius of 250'. This allows up to 0.83 G. However, *Chien 57* is inhabited by Martians, and so has been given a slower rotation, for a gravity of 0.38 G, the same as on Mars.

Spin Capsules: One or two pairs of second, smaller hulls can be attached to the main hull with shafts. Each sub-hull is a spin capsule. Build spin capsules as spherical or short (up to 2:1 length-to-width ratio) cylinder or box hulls; their *longest* dimension should not exceed the main hull's *shortest* dimension. Each should have identical dimensions, structural and armor material, and cDR; all faces must have the same armor. Each capsule requires a *spin arm:* the pylon (and machinery) that supports it. Select the spin radius (in feet); this should not exceed twice the main hull's longest dimension. Calculate mass and cost as follows:

Spin Arm Mass (tons) = Spin Radius (in feet) × Spin Capsule Spaces × 0.01.

Spin Arm Cost (M$) = Spin Arm Mass × 0.1.

A spacecraft cannot change facing without canceling spin first, because the spinning segment acts as a gyroscope. If a spacecraft uses spin capsules, a *second* pair of counter-rotating capsules negates this effect.

Spin Tethers: A common method of producing artificial gravity on small vessels is to use a spin tether: two inhabited sub-hulls are linked by a nanofiber cable 6,000' long and spun using the spacecraft's (subsumed) reaction-control thrusters. To design a vessel with a spin tether, give it two sub-hulls, which must be of equal mass; there will usually be a third, unmanned central hull as well. The tether itself masses 0.01 ton per ton of sub-hull mass (excluding the tether) and costs M$0.02 per ton of sub-hull mass. If the tether can be retracted, it requires 1 space per 12.5 tons of sub-hull mass. A spacecraft using spin tethers must retract them and cancel its spin before accelerating or changing facing.

INTERNAL SPACE AND ESTIMATED MASS

Internal Space is the volume, measured in spaces, available inside a vessel for the components described under *System Modules* (below). For manufactured hulls, it is equal to the number of spaces calculated using the formulae given under *Hull Shape* (p. 173). For asteroid hulls, it is equal to (Hull Spaces - Waste Spaces).

Estimated Mass is optional but useful at this stage. It is a working estimate of the spacecraft's final, loaded mass. It is helpful when deciding which components to place in the hull, but will be ignored after the craft is designed. Set whatever estimated mass seems correct; a good estimate is Total Hull Mass (Armor Mass + Structural Mass, for manufactured hulls) + Total Hull Spaces × 6 tons.

SYSTEM MODULES

A "system module" is a set of components grouped together in modular fashion, such as a bridge or drive. Each system is rated for the spaces it takes up. Select systems whose total spaces are sufficient to fill the spacecraft's Internal Space.

Keep a running total of remaining Internal Space; when it is gone, no more systems can be installed inside the hull. Every spacecraft should have bridge or cockpit, sensor, and power systems. Other systems are more-or-less optional, although life support, drives, and quarters should be installed in most vessels.

Likewise, keep a running total of remaining surface area; when it is gone, no more systems that require area can be installed.

System Statistics

Each system has a set of statistics, including:

Space: The space the system takes up.

Mass: The system's mass, in tons.

Cost: The system's price, in millions of dollars (M$).

Power: The system's power consumption (if any), in megawatts (MW). See *Power Systems* for details on power requirements. Some systems require negligible power. These can normally be ignored, but if the vessel has no other power requirements, then assume it requires 0.05 MW to run these systems.

Area: The surface area the system takes up, in ksf. Many components do not require area.

In some cases, a system's capabilities and statistics may vary, generally with volume. If so, then choose a number of spaces, which determines most of the system's other statistics. Some systems have extra statistics, such as thrust, output, and reaction-mass consumption; see the individual descriptions. Systems are always optional unless noted; e.g., a station does not need a space drive.

CONTROL SYSTEMS

All spacecraft require at least one of the following control systems. Large craft often add a second system as backup – often but not always a smaller, less-capable system.

Basic Bridge

A rudimentary control room for the average freighter or combatant. Access is via a one-man airlock (not necessarily in the bridge, but usually nearby). It has crew stations for four people (not all need to be manned). Its "brain" is a pair of high-capacity mainframes (old, Complexity 8) or genius mainframes (new, Complexity 9), one acting as backup. It includes two of each of the following: broadcast radios (0.1 AU range), tight-beam radios (0.1 AU range), laser communicators (0.04 AU range), precision stellar and inertial navigation gear, "black box" flight recorders, and radar/laser detectors (detect any operating ladar or radar at twice the sensor's range, as well as any such system targeting the vessel). It also includes a damage-control system that incorporates fire suppression (using inert gas or microbot swarms to smother fires within microseconds). It has a limited life-support system with 8 man-days of air and water; this is can serve as a primary life-support system on vessels without quarters (p. 152), or as a backup.

Command Bridge

Designed for larger craft. It is identical to the Basic Bridge except as follows: it has a two-man airlock and crew stations for eight bridge officers; its computers are a pair of high-capacity macroframes (old, Complexity 9) or genius macroframes (new, Complexity 10); and it has 16 man-days of limited life support.

Cockpit

Intended for short-range spacecraft, such as shuttles and work pods. It has the same features as the Basic Bridge except as follows: its communicators have only 10% of the range; it has space for only one seated person, with two man-days of life support; and there is no airlock (access is via a hatch or canopy).

Unmanned Controls

Typical of unmanned slowhaulers, RSVs, and AKVs, this is essentially a Cockpit minus the crew station and life support. With suitable software, it can autonomously direct a spacecraft.

CONTROL SYSTEMS TABLE

System	Space	Mass	Cost	Power
Unmanned, Old	0.05	0.38	0.21	neg.
Unmanned, New	0.05	0.38	3.10	neg.
Cockpit, Old	0.10	0.44	0.21	neg.
Cockpit, New	0.10	0.44	3.10	neg.
Basic Bridge, Old	1.00	2.20	0.24	neg.
Basic Bridge, New	1.00	2.20	3.10	neg.
Command Bridge, Old	2.00	3.80	0.84	neg.
Command Bridge, New	2.00	3.80	15.00	neg.

SENSORS

Sensors – typically steerable radar and infrared arrays – enable a spacecraft to see where it is going and to detect other spacecraft. Every mobile spacecraft requires at least one sensor system for navigation. No spacecraft requires more than one, but extras are often installed as backups. Sensor arrays provide global coverage. Range in atmosphere is 1,000 miles (large), 500 miles (medium), or 250 miles (small). Space range is greater, depending on the sensor.

PESA: A suite of passive electromagnetic sensors, including radio, infrared, and optical telescopes. A PESA provides a visual and infrared picture of an object: clear within about one-tenth range, otherwise a simple "blob" that reveals only temperature and brightness. Range to image objects in space is multiplied by 10, or by 100 if their location is already known.

Radar: An imaging radar. A scan reveals the range to an object, and its general shape and size, but not details such as color. Unlike a PESA, it provides precise range information. Multiply range by 10 in space.

Ladar: A laser-based sensor capable of resolving a detailed image of an object, but only if it was first detected by other sensors. With proper software, ladars can also perform spectroscopic analysis. Ladars are normally installed only in military and prospecting vessels. Multiply range by 10 in space.

All sensors have a Scan rating. This is the skill modifier when making sensor scans. The first value is if the target is in atmosphere or on a planet or other body, the second is if the target is in space.

To determine the range at which an object can be easily detected via PESA, radar, or ladar, look up the sum (Scan + object's Size Modifier + 10) in the Size column of the *Size and Speed/Range Table* on p. B201; the number in the adjacent Linear Measurement column is the range. Add +6 to Scan if using a PESA and the target is presently using any drive other than a mass driver engine.

SENSORS TABLE

Component	Space	Mass	Cost	Power	Scan
Small Ladar or Radar	0.25	2.5	1.5	1.25	25/31
Small PESA	0.25	2.5	4.8	neg.	25/37
Medium Ladar or Radar	1	10	2	5	27/33
Medium PESA	1	10	6.4	neg.	27/39
Large Ladar or Radar	4	40	3	20	29/35
Large PESA	4	40	9.6	neg.	29/41

Even larger arrays are possible: start with a large PESA, radar, or laser, decide on the bonus to Scan, add one, square it, and apply this as a multiplier to the space, mass, cost, and power of a large array. Each +2 to Scan represents a doubling of range.

Sensors that cover only a single hemisphere (usually forward or rear) are available at half space, mass, cost, and power. These are common on short-range vehicles.

SPACE DRIVES

A space drive accelerates and decelerates the spacecraft, and may also provide power. Space drives usually fire reaction mass (often heated to add energy) out the back of the vessel, which provides thrust. All space drives include, at no extra cost, a low-thrust reaction-jet system capable of changing the spacecraft's facing and allowing it to perform docking maneuvers.

Newer deep-space vessels typically use fusion or antimatter drives, while obsolete vessels use fission drives, plasma sails, or mass drivers. Craft built to take off from Earth, Mars, or Venus typically use laser or chemical rockets. Craft built to lift from Titan usually use methane-burning fission rockets. Craft built to lift from Luna or Mercury usually use fission drive or laser rockets.

Chemical Rockets

These burn a mixture of chemical fuel and oxidizer, generating a hot gas which is expelled to create thrust. They are cheap, and have high thrust-to-mass ratios, but are very thirsty. For heavy-lift applications, laser rockets have superseded chemical rockets, but vehicles that cannot rely upon an off-board laser for support (such as frontier or military craft) continue to use chemical rockets. Kerosene-oxygen rockets are standard for liftoff from Earth, hydrogen-oxygen rockets are the most efficient, while metal-oxygen rockets can be fuelled using materials manufactured on Luna.

Laser Rockets

Laser rockets use an off-board laser to heat a reaction mass (typically an ablative plastic lining the interior of the drive) which provides thrust. They require a large ground-based laser installation. Laser-driven craft are usually fairly small, due to the high power requirement.

Mass Driver Engines

A mass driver is an electromagnetic catapult, or coilgun. It can use practically anything as reaction mass. It is often installed in an asteroid in conjunction with a rock crusher. As the rock crusher digests asteroid material, it feeds it to the mass driver, which accelerates loads of powdered rock dust (or ice) to produce thrust. This allows asteroids to be moved about the solar system, consuming a fraction of their mass in the process. A mass driver needs to be fairly long to produce meaningful thrust.

Fission Drives

Fission drives are nuclear thermal rockets. A built-in nuclear reactor heats reaction mass (hydrogen, methane, or water) to produce a hot, high-velocity exhaust. A fraction of the drive's output is tapped to generate electrical energy. Fission drives are usually found in old spacecraft, or those designed for short-duration trips, such as between Earth orbit and Luna.

Fusion Pulse Drives and Antimatter Pulse Drives

These are the preferred drives for fast interplanetary travel. In the fusion pulse drive, tiny fuel pellets are ignited by laser beams to create a series of pulsed microexplosions that generate a hot plasma, producing thrust. Antimatter pulse drives are similar, but use antimatter particles instead of lasers for ignition. The antimatter pulse drive engine has a better thrust-to-mass ratio, but is more costly to operate. Two versions are available: high-impulse drives (with superior fuel economy) and high-thrust drives (with greater acceleration).

Fusion Torch Drives

These are used for long deep-space voyages to the outer solar system. An optimized fusion reactor heats a reaction mass to create a hot, high-velocity exhaust. A fusion torch cannot produce very high thrust, but it can sustain acceleration for days at a time. Hydrogen is the usual reaction mass, but some spacecraft carry water instead of hydrogen to increase thrust. As with pulse drives, both high-impulse and high-thrust versions are available.

Nuclear Light Bulbs

These are obsolete high-temperature, closed-cycle fission drives that use gaseous rather than solid nuclear fuel. The hot plasma is held in a transparent crystal capsule. Thermal radiation passes through to heat hydrogen propellant. Thrust-to-mass ratio is inferior to an ordinary fission rocket, but efficiency is higher. Older deep-space craft often use nuclear light bulbs.

Plasma Sails

A plasma sail generates a magnetic field, then injects hydrogen plasma (ionized gas) to inflate it into a huge bubble around the vessel. This "mini-magnetosphere" acts as a giant sail, catching the solar wind's charged particles and accelerating the vessel (to a maximum practical speed of 150 miles per second). The plasma bubble "leaks" a tiny amount of hydrogen as it operates, and thus has a (low) fuel requirement. Its performance is sufficiently superior to both light sails (propelled by light pressure from the sun) and magsails (which catch the solar wind using a magnetic field generated by superconductor loops) that it superseded both. A craft under plasma sail is enveloped in a wispy blue-white nebula of ionized gas that leaves a short, comet-like trail. A vessel may have no more than 10 plasma-sail modules.

Ion Drives

Low-thrust, high-efficiency thrusters, usually used for unmanned cargo vessels or orbital station keeping. Require a separate power plant.

Atmospheric Engines

Streamlined spacecraft sometimes carry an auxiliary "air-breathing" engine that allows more fuel-efficient operation in atmosphere. Two examples:

Fission Air-Ram: Sucks in air, heats it using an integral fission reactor, and expels it as reaction mass. It requires some sort of atmosphere, but it need not be breathable: it works on Venus, Earth, Mars, Titan, and in gas-giant atmospheres.

Turbo-Scramjet: An advanced air-breathing, kerosene-burning supersonic combustion engine coupled to a turbofan for low-speed flight. It is only functional in Earth or Mars atmosphere.

Installing Drives

Each drive is rated for thrust in tons and reaction-mass consumption (RMC) in spaces per hour – both *per space of drive.* A spacecraft's nominal acceleration in Gs is equal to its thrust divided by its mass.

To determine how many spaces of drive are needed for a desired acceleration, divide the craft's Estimated Mass by the thrust shown, multiply by the desired acceleration in Gs, and round off. If this requires more spaces of drive or more reaction mass than is practical, then try a lower acceleration.

Reaction-mass consumption is critical. Extreme thrusts often require more reaction mass than can fit in the vessel; see *Tanks* (p. 180). In general, deep-space craft strive for accelerations of about 0.1 G to 0.3 G, sustainable for several hours. This allows a relatively fast trip and the ability to land on or take off from small moons. Craft designed to lift off from Earth or another large body must have accelerations greater than that body's surface gravity and must be able to develop a delta-v (see *Tanks*) in excess of orbital velocity (see Chapter 2).

Decide on the type of drive and number spaces of drive (maximum 10 spaces if plasma sail), then determine performance using the *Space Drives Table.* All drives except nuclear light bulb and fusion torch exist in 0.5- and 0.25-space versions (chemical and laser rockets, and turbo-scramjets, can be taken in 0.1-space increments), at proportionately reduced Thrust, Mass, Cost, Output, Power, and RMC.

SPACE DRIVES TABLE

Space Drive	Thrust	Mass	Cost	Output	Power	RMC	ISP
Chemical Rockets:							
– metal-oxygen	160	4	0.4	0	0	100MO	274
– kerosene-oxygen	330	4	0.2	0	0	215KO	395
– hydrogen-oxygen	330	4	0.2	0	0	660HO	514
Laser Rocket	200	4	0.2	0	*	40P	1,500
Mass Driver Engine	0.1	4	0.4	0	4	0.02RD	720
Fission Drive	27	4	0.8	1	0	94H	1,034
Fusion Pulse Drives:							
– high-impulse (HI)	4	4	0.4	1	0	0.04N	30,000
– high-thrust (HT)	8	4	0.8	1	0	0.16N	15,000
Antimatter Pulse Drives:							
– high-impulse (HI)	4.8	4	1	2	0	0.04N**	36,000
– high-thrust (HT)	9.6	4	2	2	0	0.16N**	18,000
Fusion Torch Drives:							
– high-impulse (HI)	0.4	4	0.8	1	0	0.04H	36,000
– high-thrust (HT)	1	4	0.8	1	0	0.25H	14,400
Nuclear Light Bulb	4	4	0.4	1	0	6H	2,400
Plasma Sail	0.01	4	4	0	1	0.001H	36,000
Ion Drive	0.004	4	0.4	0	0.64	0.0002A	9,350
Atmospheric							
Fission Air-Ram	20	4	0.8	1	0	n/a	n/a
Turbo-Scramjet	40	4	0.4	0	0	1J	13,333

Thrust: Tons of thrust per space of drive. Atmospheric drives produce *no* thrust in space.

Mass (in tons), *Cost* (in M$), and *Power* (in MW) are per space of drive.

* The laser rocket has no onboard power requirement, but must be energized by an external 20-GW laser beam per space of drive.

Output: The power *generated* by the drive, in MW per space.

RMC: Reaction-mass consumption per space of drive per hour, measured in spaces (not tons) of reaction mass. A = argon, H = hydrogen, HO = hydrogen-liquid oxygen, J = jet fuel, KO = kerosene-liquid oxygen, MO = metal powder-oxygen, N = nuclear pellets, P = ablative plastic, and RD = rock dust. See *Reaction Mass, Coolant, and Fuel* (p. 187) for the mass and cost of reaction mass.

** Antimatter pulse drives also require 0.001 grams of antimatter per space per hour.

ISP: The drive's specific impulse, a measure of rocket efficiency. ISP is a constant unaffected by the number of drive spaces installed. It is the length of time for which 1 ton of propellant can produce 1 ton of thrust. The higher the ISP, the more relatively efficient the drive is. ISP is used if calculating realistic delta-v (see p. 189).

Compact Drives

A spacecraft may have a *compact* version of any of the above drives. A compact drive is not suitable for manned vessels built for long-term operation, as it cannot be maintained from within the vessel. However, as there is no need for internal access or engine rooms, it is less bulky. Multiply the Thrust, Mass, Cost, Output, Power, and RMC (including antimatter consumption) of a compact drive by 1.5. Most aerospace craft have compact drives.

TANKS

Any spacecraft with a nonzero RMC requires appropriate tankage. Tanker vessels (such as those transporting helium-3) also require tanks. Each one-space tank system is a light or ultralight self-sealing tank (or shielded storage compartment) with feed or pump mechanisms.

Burn Endurance is the time in hours for which the spacecraft can accelerate. Decide how many spaces will be allocated to tanks, and then divide by the space drive's RMC to find endurance in hours. Decide whether the tanks are light (generally made of metal) or ultralight (more expensive, generally made of composites) and calculate their mass and cost.

Delta-V is the maximum speed a spacecraft can reach by exhausting all of its reaction mass. This is *very roughly* [20 miles per second (mps) × Burn Endurance (in hours) × Thrust]/Estimated Mass. Halve this if the spacecraft is to decelerate to a stop as well (this is not required if just boosting into orbit, but is usual for interplanetary voyages). Divide delta-v in mps by 1,100 to get a rough delta-v in AU per day. Another useful approximation: the required spaces of tanks needed to achieve a specific delta-v is roughly [0.05 × Delta-V (in mps) × Estimated Mass × RMC]/Thrust.

Alternative Reaction Mass

The performance listed for mass drivers assumes rock dust, but they may use just about anything. Thrust does not change, but RMC does: the new RMC is 0.5 divided by the density of the reaction mass in tons per space (see p. 176). For example, when using ice (14 tons per space), RMC is 0.5/14 = 0.036.

Fission drives and fusion torch drives may substitute water or methane for hydrogen. If water, multiply thrust by 3, RMC by 0.6, and ISP by 1/3; if methane, multiply thrust by 2.8, RMC by 1.3, and ISP by 0.35.

TANKAGE TABLE

System	Mass	Cost
Light Tank	0.83	0.067
Ultralight Tank	0.16	0.16

Mass and *Cost* are *per space* of tank. Tanks can be bought in fractional spaces. Tanks can also be used for coolant; see *Radiators* (p. 186). Rock dust does not require tanks; install cargo space instead.

Antimatter Bay

A vessel with an antimatter drive requires an antimatter bay. This is 1 space, 25 tons, and M$0.5 per 100 grams of antimatter stored. Fractional-sized bays are possible. Antimatter is stored in magnetic traps as super-cooled antihydrogen crystals. Antimatter in excess of the nanogram quantities used in medicine and research is LC 0.

WEAPONS

Three weapons systems are in common use: *coilguns* are specialized combat mass drivers used to fire munitions packs (p. 188); Gunner skill required depends on the pack. *Lasers* and *particle accelerators* are directed-energy weapons fired using Gunner (Beams) skill.

For the purpose of these rules, *missiles* (also known as "autonomous kill vehicles" or "AKVs") are not treated as weapons systems *per se.* Build them as small spacecraft with unmanned controls and (often) their own weapons, and then install them in an external cradle, spacedock hangar, or vehicle bay (see p. 183).

Mounting Weapons

The maximum number of weapons (all types) that can be installed is limited by Total Area. A torus may have a maximum of 5 weapons per 2 ksf of Total Area. Other hull shapes may have a maximum of 5 weapons per ksf of Total Area.

Each weapon must be given a specific facing, either front (F), sides (S), or back (B). ("Sides" is used because a vessel in space can easily rotate around its long axis, making distinctions between right, left, top, and underside meaningless.) The maximum number of weapons that can be mounted on a given hull per facing depends on hull shape:

Box, Cylinder, Streamlined Cylinder: The maximum weapons per facing is equal to 5 times that facing's area (one per 0.2 ksf).

Sphere: The maximum weapons per facing is equal to Total Area for front and back, and 3 times Total Area for sides.

Streamlined Delta: The maximum weapons per facing is equal to Total Area for front, 2.5 times Total Area for sides, and 1.5 times Total Area for back.

Torus: The maximum weapons per facing is 0.5 times Total Area for front and back, and 1.5 times Total Area for sides.

The above restrictions notwithstanding, a vessel can always mount at least one nonturreted weapon (facing optional), regardless of its size.

Coilgun Bay

This is a launcher for kinetic-kill or X-ray laser warhead munitions. The system includes a 333mm electromagnetic gun and room for one munitions pack (p. 188). It takes up 0.5 spaces, masses 0.16 tons (empty), costs M$0.08, and uses 1 MW of power. It requires 0.1 ksf of surface area.

LASER TABLE

Weapon	Space	Mass	Cost	Power	Area	Drain
2.5-MJ Light Laser	1	5	2	5	0.1	500
– if tower	1.5	5.8	2	5	0.1	500
10-MJ Heavy Laser	4	18.5	4.7	20	0.1	2,000
– if tower	6	20.3	4.7	20	0.1	2,000

Space, Mass, Cost, Power, and *Area:* The space the laser takes up, its mass in tons, its cost in M$, its power requirement in MW, and the surface area it requires.

Drain: The MJ drained per space combat turn. This is used if the laser is being powered by an energy bank (p. 186) rather than a drive or reactor.

Lasers

A standard space-combat laser system consists of a free-electron laser designed to lase in the ultraviolet with a variable-focus, diffraction-limited mirror. Large mirrors have engineering problems which result in resolutions no better than those of smaller mirrors, so most craft use banks of lasers, all focused on the same point. The laser system includes a steerable mirror – no actual turret is necessary. Two types of lasers are standard: 2.5-MJ lasers are widely used by civilian vessels for "meteor defense," while 10-MJ lasers are military weapons.

Laser Towers: Some of a box, cylinder, or sphere hull's side-facing lasers may have their mirrors installed in retractable tower mounts. These can fire forward or backward as well as to the side. The number of side-facing lasers that can be designated as laser towers may not exceed 1/3 a cylinder or sphere's diameter (in feet) or 1/5 the *higher* of a box's width or height (in feet).

Particle Accelerators

These weapons accelerate focused beams of neutral subatomic particles to speeds approaching that of light. They are shorter-ranged and more costly than lasers, but more lethal, killing crews via radiation damage. All nations restrict civilian spacecraft from possessing particle-beam weapons.

To design a particle accelerator, decide if it is an old or new design; new designs are post-2080. Then select accelerator tube length in multiples of 50 feet. An accelerator facing front or back may not be longer than the hull's length (if box, cylinder, or streamlined delta), width (if sphere), or cross-sectional diameter (if torus). One facing sideways may not be longer than the hull's width (if box, cylinder, sphere, or streamlined delta) or cross-sectional diameter (if torus). The largest particle accelerator presently available is 400' long.

Determine characteristics using the table below:

PARTICLE ACCELERATOR TABLE

Weapon Type	Space	Mass	Cost	Power	Drain
Old	8	40	4	20	2,000
New	4	20	16	10	1,000

Space, Mass, Cost, Power, and *Drain* are per 50' of accelerator length. See *Lasers* (p. 181), for an explanation of Drain.

CREW AND PASSENGERS

A spacecraft with a cockpit may have passenger seating; a spacecraft with a bridge will normally have quarters as well. Large spacecraft (typically, space stations) may be equipped as habitats.

Passengers in nanostasis (p. 166) do not require quarters, but they may be carried as cargo. (A nanostasis unit with passenger is 0.5 tons and 0.1 space.)

Crew Requirements

Most vessels are capable of operation with a single crewman (to tell the computers what to do) or no crew at all, but human crews are desirable – both because they surpass all but the most expensive SAIs in decision-making capability and because SAIs are not legally competent for certain types of command decisions. Human crew can often be replaced with cybershells, which can be carried as cargo. Intelligent agents and programs usually manage sensors, communications, and so on. Some suggested crew positions:

Commander: The master of the vessel. On small vessels, he may be the only crewmember. Relevant skills: Shiphandling, Administration and Leadership (if he supervises other crew), and Tactics (if he must engage in combat).

Pilot: Plots the vessel's course and performs maneuvers. Relevant skills: Astrogation and Piloting.

Weapons Officer: Directs the fire of the vessel's weapons and gives orders to autonomous kill vehicles. Usually only found aboard military vessels. Aboard armed civilian craft, the commander or pilot handles this task. Relevant skills: Gunner (Beams) and Gunner (Railgun).

Collectively, the commander, pilot, and weapons officer are known as "bridge crew."

Engineer: In charge of routine maintenance and directing damage-control teams (usually cybershells or microbots). Also fixes the robots if they break down. Relevant skills: Mechanic (Reaction Drive), Mechanic (Robotics), and Mechanic (Spacecraft).

Purser: On commercial spacecraft, the purser looks after the needs of paying passengers, if any, supervising stewards and other service personnel.

Steward: Provides individual attention to luxury passengers. A luxury liner or yacht may carry one for every two to four luxury cabins.

Mission Specialists: Anyone needed to perform special tasks: mining engineers, scientists, etc.

Cook: A liner, station, or large combat vessel may have human cooks aboard.

Quarters and Seats

Manned spacecraft designed for long-term operation require bunkrooms or cabins. Those built for short-term operation, such as shuttlecraft, may install passenger seating instead of quarters if they carry more occupants than provided for in the cockpit or bridge.

Bunkroom: A room with four bunk beds (each with a small locker), intercom, controls for light and temperature, and shared sanitary facilities.

Cabin: A furnished room capable of housing one or two people. Contains a bed, chairs, and a desk; a closet; a toilet, sink, and shower; and video walls. Furniture is capable of internal reconfiguration to save space. Life-support systems are installed beneath the floor and above the ceiling.

Luxury Cabin: As cabin, but with superior fittings: full 3D video walls, wombskin beds, etc.

Passenger Seats: Each space has 16 seats. The system's built-in air supply also provides two man-days of life support per seat. Half- (8 seat) or quarter-space (4 seat) increments are possible.

Bunkrooms, cabins, and luxury cabins have regenerative life-support systems capable of providing indefinite air and water. These can be overloaded if necessary. Roll 3d after each day of overloading, at +1 per full 10% by which the number of people aboard exceeds current system capacity. On an adjusted roll of 13 or more, the system begins to break down, losing 10% of its *current* capacity for each point by which the roll exceeds 12.

A Mechanic (Life Support) roll can be attempted once per day; if it succeeds, it will restore 10% of *full* capacity. Once the life-support system begins to fail, the effect snowballs. If the spacecraft remains overloaded, life support will eventually reach 0% and fail. At that point, all oxygen in the air will be used up within a few hours, and everyone will die. Those in nanostasis are unaffected if life support fails.

QUARTERS TABLE

System	Space	Mass	Cost	Power	Note
Bunkroom	1	0.5	0.044	0.04	4 people
Cabin	1	1	0.01	0.02	1-2 people
Luxury Cabin	2	2	0.02	0.02	1-2 people
Passenger Seats	1	1.4	0.02	neg.	16 seats

Storm Shelters

Massive solar flares, the radiation belts of gas giants, and (for combat vessels) particle accelerator fire can generate lethal levels of radiation. Stopping this requires shielding many feet thick. However, shielding an entire spacecraft usually adds too much mass to be practical. Instead, most vessels incorporate *storm shelters:* protected areas into which crew and passengers can retreat in an emergency. Most deep-space craft will install one storm shelter around their bridge or cockpit. If they carry additional crew or passengers who will not be on duty in the bridge or cockpit, they install shelters around a few spaces of added passenger seating or bunkrooms. For a few hours, as many as 10 passengers can cram (standing room only) into each space of bunkroom or cabin, provided the vessel's overall life-support capacity is not exceeded.

0.1-Space Shelter: This protects 0.1 space. Specify a 0.1-space system that it protects, usually a cockpit or unmanned controls.

1-Space Shelter: This protects a single space. Specify a one-space system that it protects, usually a basic bridge, bunkroom, or passenger seats.

2-Space Shelter: This protects two spaces, usually a command bridge, or two spaces of bunkrooms or passenger seats.

Storm shelters provide additional radiation protection for anyone inside them. A *light* shelter has cPF 100; a *heavy* shelter has cPF 1,000.

STORM SHELTERS TABLE

Type	Spaces	Mass	Cost
Light 0.1-Space Shelter	3	240	2.4
Light 1-Space Shelter	7	560	5.6
Light 2-Space Shelter	11.5	920	9.2
Heavy 0.1-space Shelter	9	720	7.2
Heavy 1-Space shelter	16.5	1,320	13.2
Heavy 2-Space shelter	21	1,680	16.8

Habitat Modules

Space stations (and very large vessels) may contain large urban or green areas. Unless noted, each module described below is about the size of a city block, and includes lighting, temperature control, and air circulation.

There is a limit of one farm or housing module per 50 ksf of Total Area. Treat gardens or vatfacs as 0.1 farm module. For example, a torus with 2,000 ksf Total Area could have 40 housing modules.

Factory: A large industrial park containing warehouses and robotic factories, capable of operating efficiently with a few dozen workers or robots, but limited to building a specific range of products.

Farm: An acre or so of open space with a few buildings devoted to agriculture and food processing. Up to 10 people or human-sized cybershells (or equivalent microbot swarms) can work it efficiently; each worker can grow sufficient food to feed 20 people using genemod crops, or 10 with more "natural" crops. It also acts as total life support for about 100 people. Can double its yield, but this requires an extra 100 tons of fertilizer a year.

Garden: A smaller farm module, about 0.1 acre, with exactly 1/10 the capacity.

Housing: One or more apartment buildings or several houses, plus surrounding grounds. Provides long-term accommodation for up to 100 people in conditions far more open than quarters.

Open: Simple empty space, but pressurized and including the mass of air.

Park: A landscaped green space, possibly with entertainment or exercise facilities (pools, streams, playgrounds, etc.). Can provide campgrounds for about 100 people.

Plaza: A mall or concourse area with a dozen or so medium-sized establishments, plus substantial open space for several hundred people to congregate around them.

Robofac: A state-of-the-art factory, fully autonomous and capable of building just about anything. See p. 153.

Vatfac: A smaller module containing vats used to grow fauxflesh, pulp, industrial bacteria, or similar products. Provides as much food as a garden module, or half as much while processing it into imitation flesh, etc. Does not provide life support.

Habitat Modules Table

System	Spaces	Mass	Cost	Power
Farm	10,000	2,000	0.5	3
Factory	10,000	50,000	10	10
Garden	1,000	200	0.05	0.3
Housing	10,000	4,000	1	0.1
Open	10,000	100	0.01	0
Park	10,000	2,000	0.2	2
Plaza	10,000	3,000	1	0.1
Robofac	10,000	50,000	1,000	100
Vatfac	1,000	200	0.1	0.1
Reconfigurable	×1	×1.2	×2	+1

Option: Reconfigurable: A housing or plaza module can be reconfigurable. This allows the module to reshape itself. The basic use of the module (e.g., housing) does not change, but the internal configuration can be altered. It takes a few minutes to a few hours to reconfigure.

Accessories

Various auxiliary systems may be installed, such as scientific equipment, recreational facilities, large airlocks, or bays for smaller craft or missiles.

Atmosphere Processor: Processes gas-giant atmosphere into hydrogen and helium-3. It can process about 12 spaces per hour.

Entry Module: An entry module consists of a retractable, flexible, 100'-long passage tube designed to mate with any other vessel's airlock, along with either a 4-person (small module) or 8-person (large module) airlock.

External Cradle: This is placed on the hull of a spacecraft. Each module clamps 125 tons of another vehicle to the hull. Individual modules can be combined to form larger external cradles, or installed in half-space increments to hold smaller craft. Vessels carried in this way do not take up internal space and are not protected by the spacecraft's cDR.

Fuel Electrolysis Unit: A system for cracking water into hydrogen and oxygen. It can crack one space of water into 1.58 spaces of liquid hydrogen and 0.76 space of liquid oxygen every three hours.

Hall, Bar, or Conference Room: A large, fully furnished room that can be used as a restaurant, bar, conference room, etc. Can hold up to 50 people (smaller lounges and conference rooms are included in the volume of quarters).

Lab: An equipment-filled laboratory designed for a specific Scientific skill (pp. B59-62). Gives a +2 bonus in situations where lab equipment is helpful but not necessary, or no bonus in situations where a laboratory *is* necessary. Power is 0.3 MW for a physics lab.

Minifacturing Workshop: A workshop with a large universal 3D printer and appropriate tools and spare parts for using Armoury, Electronics, Engineer, and Mechanic skills. Up to three people can use it at once; it gives +2 skill.

Robot Arm: A telescopic mechanical arm that folds snuggly inside the hull. It is intended for loading and external manipulation. It is 19' long and ST 690 if large, 15' and ST 430 if medium, and 12' and ST 280 if small.

Rock Crusher: This system mines asteroid rock and converts it into loose dirt that is usable as reaction mass for a mass driver. Each space of rock crusher can crush 1 space of rock into 1 space of rock dust every 10 hours.

Spacedock Hangar: A pressurized hangar bay designed to house smaller craft within the spacecraft. Its airlock doors or landing-pad elevators open into space, but the hangar itself is sealed, and includes air pumps to evacuate or pressurize it within one minute per space of size. Choose the height, width, and length of the hangar in feet; spaces required = (Height × Width × Length)/500. A vehicle can enter the hangar if its *longest* dimension is less than the bay's *shortest* dimension. The hangar uses up ksf of surface area equal to (Height × Width)/1,000. When determining whether spacecraft can fit into a spacedock, do not forget to account for the dimensions of spin-capsule arms and radiator wings.

Accessories Table

System	Space	Mass	Cost	Power	Area
Atmosphere Processor	1	5	1	12	–
Entry Module, Small	0.5	2	0.007	neg.	–
Entry Module, Large	1	3	0.011	neg.	–
External Cradle	1*	12.5*	0.25*	–	2
Fuel Electrolysis	0.25	1.25	0.125	14	–
Hall, etc.	10	0.2	0.03	neg.	–
Lab	2	10	1	neg.	–
Minifac Workshop	0.1	0.5	1	neg.	–
Robot Arm, Small	0.25	0.37	0.1	neg.	0.02
Robot Arm, Medium	0.5	0.69	0.15	neg.	0.03
Robot Arm, Large	1	1.3	0.28	neg.	0.05
Rock Crusher	1	4	0.2	1	–
Spacedock	var.	1**	0.005**	0	var.
Surgery	0.5	0.14	0.05	neg.	–
Vehicle Bay	var.	0.5**	0.003**	0	var.

* Per 125 tons of loaded mass of vehicle carried. Round spaces to nearest 0.1 space.

** Mass and cost are paid only once, regardless of the number of spaces making up the spacedock hangar or vehicle bay, and represent the mass and cost of the hangar doors and air pump.

Surgery: A well-equipped surgery – including an operating table (fully gyrostabilized for onboard use), diagnosis table, and ESU – that allows one person to be operated on at a time.

Vehicle Bay: A snug conformal bay designed to house one specific model of auxiliary spacecraft or vehicle. A door, slide, etc. leads directly into the craft. The craft exits through hangar doors. Spaces required = (Spaces of Auxiliary Vehicle × 1.05). The surface area required is 1/4 of the auxiliary's Total Area if a sphere, 1/6 of its Total Area if a streamlined delta, or its front area if a box or cylinder. Spacecraft with torus hulls, non-retractable radiator wings, or spin capsules cannot be carried.

POWER SYSTEMS

Every spacecraft needs a power source. Fission and fusion drives generate power using built-in magnetohydrodynamic turbines (see *Space Drives,* p. 178). If such drives are not installed, or are insufficient to meet the vessel's power requirements, then separate power systems must be added.

POWER PLANT TABLE

System	Output	Mass	Cost	End.
Fission Reactor, Old	2	4	0.4	2
Fission Reactor, New	4	4	0.8	2
Fusion Reactor, Old	4	4	0.8	20
Fusion Reactor, New	8	4	1.6	200

Output, Mass, and *Cost* are per space of power plant. Power plants may also be taken in half-space increments, with half the listed output, mass, and cost.

End.: The operating endurance of the plant, in years, based on the usual internal fuel. All power plants can be refueled.

POWER CORE TABLE

System	Space	Mass	Cost	Notes
Fission Core, Old	1	4	0.61	For old fission reactor.
Fission Core, New	0.5	2	0.25	For new fission reactor.
Fusion Core, Old	25	100	5	For old fusion reactor.
Fusion Core, New	2.5	11	5	For new fusion reactor.

Power is measured in megawatts (MW). (As a comparison, the Niagara Falls power plant produces some 500 MW.) Add up the power requirements (in MW) of all systems installed so far. If some systems will only run periodically (e.g., fuel electrolysis), then tally the largest *simultaneous* requirement envisaged. This gives the power requirement in MW. If the vessel's drives are insufficient to meet this requirement, then install sufficient power plants, solar panels, or energy banks to meet the demand.

Power Plant and Power Core

If the spacecraft will have a power plant, then select one from the table below. Install sufficient spaces of power plant to provide the required power.

For each fission or fusion reactor installed, regardless of size, also install *one* power core of the same type. It contains vital engineering-room control space.

Solar Power

This alternative to reactors produces power from sunlight.

Solar Panels are attached to a lightweight frame external to the vessel. They are quite vulnerable to damage, and are disabled at 0.1 G or more (whether from acceleration or gravity).

As well, they are easily destroyed in space combat.

Folding Solar Panels are designed to retract flush with the vessel (taking 10 seconds). If retracted, they do not provide power but are no longer vulnerable to damage.

Solar Cells are built onto the vessel's hull. They use up surface area, but are not affected by acceleration and are harder to damage in combat.

SOLAR POWER TABLE

System	Spaces	Mass	Cost	Output	Area
Solar Panels	0	0.08	0.036	0.08	0
Folding Solar Panels	0.0032	0.16	0.072	0.08	0
Solar Cells	0	0.05	0.03	0.08	1

Spaces, Mass, Cost, Output (in MW), and *Area* are per ksf of panels or cells. The listed Output values assume operation in a vacuum, at light levels equal to those 1 AU from Sol. Actual output varies with the square of the distance to the sun (e.g., doubling distance to 2 AU cuts output by a factor of 4), so solar power is almost useless to spacecraft in the Deep Beyond.

Energy Banks

Energy banks are normally used to power systems whose transitory power requirements outstrip the capacity of ordinary power plants. Energy is measured in megajoules (MJ), or megawatt-seconds (MWs); 1 MJ provides 1 MW of power for 1 second, or 1/100 MW for a 100-second space combat turn, or 1/3,600 MW for 1 hour.

ENERGY BANK TABLE

Type	Mass	Cost	Storage	Max. Power
Power Pack	12.5	0.75	9,000 MJ	9,000 MW
Battery	12.5	0.75	90,000 MJ	100 MW

Mass, Cost, and *Storage* are per space of energy bank. Energy banks are available in fractional-space increments.

Max. Power is the maximum power the energy bank can provide each second.

If using a power plant to recharge an energy bank, each MW so allocated recharges 1 MJ per second, or 3,600 MJ per hour. A spacecraft without extra power capacity may shut down other systems temporarily to recharge energy banks.

CARGO CAPACITY AND EMPTY SPACE

Leftover space in the vessel may be designated *empty space* or *cargo capacity.* Each space of cargo hold has room for 500 cf of cargo. Necessary cargo doors or ramps are included. Multiple spaces of cargo can either represent a single large hold or a number of smaller holds. Holds in fractional-space increments may also be installed. Cargo capacity and empty space have no mass or cost.

SURFACE FEATURES

These features may be added to the exterior of the hull.

LIQUID-CRYSTAL AND CHAMELEON SYSTEMS

Liquid-Crystal Skin: Allows the digital "painting" of customized color schemes, camouflage patterns, or markings onto the vessel's surface, which is useful if a quick appearance change is called for.

Chameleon Surface: Allows the vessel to change color and markings to match its surroundings. It is of limited use in space (black paint is just as good), but it is useful if the spacecraft has landed, giving -3 on all rolls to visually spot or attack the vessel, detect it with ladar, or lock on with ladar- or optically homing weapons.

SURFACE FEATURES TABLE

Feature	Mass	Cost	Power
Liquid-Crystal Skin	0.05	0.02	neg.
Chameleon Surface	0.1	0.04	neg.

Multiply mass and cost by the vessel's Total Area in ksf.

Spacecraft emit so much energy compared to the cold background of space that they show up like beacons on passive sensors. The same is true of spacecraft boosting to orbit or re-entering atmosphere, due to air friction. As such, antiradar stealth and emission cloaking are pointless. An effective visual countermeasure is painting the spacecraft black.

RADIATORS

Radiators remove excess heat from the spacecraft. All vessels employ small radiators, but extra radiators may be needed for some drives and reactors.

Required Radiator Area (RRA)

This is the area in ksf of radiators required. Add up the total requirement and record it; this statistic is used in space combat.

Fission drive, nuclear light bulb drive, or old fission power plant: 1 ksf per 8 spaces of drive or power plant.

Old fusion power plant or new fission power plant: 1 ksf per 4 spaces of power plant.

Fusion pulse drive (any), fusion torch drive (any), antimatter pulse drive (any), or new fusion power plant: 1 ksf per 2 spaces of drive or power plant.

Compact drive: Each space of compact drive counts as 1.5 spaces for purposes of RRA.

Round requirements down. Radiators may be mounted on the hull surface or on external radiator wings; install sufficient radiator panels and wings to meet the required radiator area.

Radiator Panels

Each radiator panel occupies 1 ksf. Radiator panels do not add mass or cost; this is included in the systems that require them. They only require unused surface area.

Radiator Wings

A vessel with insufficient surface area for radiator panels will usually need radiator wings. Subtract the area of any radiator panels from RRA to get the area of radiator wings required.

Radiator wings are mounted externally on lightweight structures parallel to the hull. A craft may have up to two wings; each wing's area in ksf may not exceed (Spacecraft's Longest Dimension)^2/1,000 ksf. Radiator wings are 4 tons and M$0.4 per ksf.

Radiator wings may be designed to fold up. Vessels intended to enter atmosphere may only have folding wings. Military spacecraft often have folding wings, as the radiators are vulnerable in combat. Folding wings are 0.5 space, 5 tons, and M$0.5 per ksf.

Select the dimensions of the radiator wings; they should not be longer than the craft. For instance, 4 ksf of radiator wings could be two wings, each of 2,000 square feet; a 2,000-sf wing might be 100' × 20'.

Coolant

If a vessel requires more radiator area than was installed, then it will rapidly overheat. A vessel with insufficient radiator area will shut down unless it can dump excess heat by venting water or reactor coolant, or by melting ice to water. See *Overheating and Powering Down* (p. 200) for rules covering this situation.

CONSUMABLES

These are items such as reaction mass, fuel, and ammunition that may be used up by the vessel. They add to a spacecraft's loaded mass, but do not affect its empty mass or empty cost. Record them separately.

Reaction Mass, Coolant, and Fuel

Use the following table to determine the mass and cost of any reaction mass, coolant, or fuel carried in the vessel's tanks:

REACTION MASS, COOLANT, AND FUEL TABLE

Type	Mass	Cost
Ablative Plastic (P)	12	0.001
Argon (A)	7.7	0.0013
Coolant (C)	12	0.001
Deuterium (D)	1	0.001
Helium-3 (He-3)	1.7	1.7
Hydrogen (H)	1	0.00035
Hydrogen-Oxygen (HO)	3.5	0.0003
Ice (I)	14	0.00028
Jet Fuel (J)	10.8	0.01
Kerosene-Oxygen (KO)	14	0.005
Metal-Oxygen (MO)	21	0.005
Methane (M)	6	0.0015
Nitrogen (N2)	11.5	0.0003
Nuclear Pellets (N)	12	0.006
Oxygen (O)	15.8	0.0003
Rock Dust (RD)	26	–
Water (W)	15	0.0003

Mass and *Cost* are *per space*. Use these values to calculate the following quantities:

Reaction Mass Tons: Multiply the mass shown on the table by the vessel's tank spaces.

Reaction Mass Cost: Multiply the cost shown on the table by the vessel's tank spaces.

Food Supplies

Craft without appropriate farm, garden, or vatfac modules should carry food supplies. These are usually minimal, but can be important on long journeys with large crews. Food is stored as cargo. Each cargo space of supplies stores 12,500 man-days of food, and is 12.5 tons and M$0.075.

Munitions Packs

Munitions packs are warhead-guidance system packages that can be launched from coilgun bays. Each bay can carry one ready-to-fire munitions pack. Additional munitions packs can be carried as cargo for later reloading.

Kinetic Kill Munitions Pack (KKMP): This package contains several canisters housing many thousands of tungsten pellets designed to be released while on a converging course with a target. KKMP packs are commonly available.

X-ray Laser Munitions Pack (XLMP): This package contains several canisters housing multiple nuclear-bomb-pumped X-ray laser warheads. The munitions are ejected in a spread pattern in order to avoid fratricide when the warheads fire, and then are detonated simultaneously, producing a lethal barrage of X-ray laser beams. XLMP are new and normally only available to the military forces of China, the European Union, the PRA, and the United States. The first were deployed in 2089.

MUNITIONS PACK TABLE

Type	Mass	Cost
KKMP	9.5	0.224
XLMP	9.5	5.57

If not carried in a coilgun bay, each munitions pack occupies 0.5 space as cargo.

STATISTICS

The spacecraft design is now complete. Calculate its capabilities.

Mass

A spacecraft's mass affects its performance.

Empty Mass (EMass): Add together the mass of the hull, armor, surface features, and all installed systems. *Do not* include the mass of consumables (ammunition, food, reaction mass, etc.).

Payload: Calculate the payload by summing the following:

- The mass of cargo. If exact numbers are unknown, assume 5 tons per space of cargo hold (i.e., about 20 lbs./cf), which allows for cargo holds that are not full, container mass, etc. A density of 12-18 tons per space of hold is reasonable if hauling dense, heavy loads, but acceleration will be much lower. Include the mass of any provisions.
- The mass of occupants. Assume 0.1 ton per person. As a rule of thumb, this can be simplified to 1.5 tons per passenger seat system, 0.5 ton per space of bunkroom, or 0.2 ton per cabin or luxury cabin. If no cabins or bunkrooms, also add 0.1 ton per cockpit, 0.3 ton per basic bridge, and 0.6 ton per command bridge.
- The loaded mass of vehicles (including missiles) in vehicle bays or spacedock hangars.
- The mass of ammunition (munitions packs).

Reaction Mass Tons: See p. 187.

Combat Mass (CMass): Combat Mass = EMass + Payload + (Reaction Mass Tons)/2. Reaction Mass Tons is halved because the tank will be partially used during the flight. Calculating CMass using a half-tank is a way of approximating more complex rocket equations.

Dry Mass: Dry Mass = EMass + Payload only. Dry Mass is used in the more realistic delta-v equations on p. 189.

Loaded Mass (LMass): Loaded Mass = EMass + Payload + Reaction Mass Tons + fuel tonnage. It is used to determine how much the vessel will mass when transported, and whether it can take off from the ground.

Round masses of 10 tons or more to the nearest whole number; round masses under 10 tons to one decimal place.

GMs may wish to calculate multiple sets of performance figures for spacecraft whose mass parameters can change dramatically; e.g., with near-empty vs. full cargo holds or spacedocks.

Cost

Add together the cost of the structure, armor, surface features, and all installed systems to get the spacecraft's cost. Round costs of M$10 or more to the nearest M$. Round costs between M$1 and M$10 to one decimal place. Do not round costs under M$1.

Size Modifier (SM)

Calculate a spacecraft's size modifier by looking up its dimensions in the Linear Measurement column of the table on p. B201 (be sure to convert feet to yards: 3 feet = 1 yard) and reading across to the Size column. Most vessels have a single SM, based on their longest dimension. Cylinders have two SMs: the first is used for attacks from the front or back, and is based on width; the second is used for attacks from the sides, and is based on length. If a vessel has two SMs, separate them with a slash; e.g., +3/+5.

Also calculate a SM for radiator wings, based on their longest dimension.

For reference:

Linear Measurement:									
9'	14'	21'	30'	45'	60'	90'	135'	210'	300'
SM:									
+1	+2	+3	+4	+5	+6	+7	+8	+9	+10

If the linear measurement falls between two values, use the higher of the two.

Health and Hit Points

Health (HT) is a measure of reliability. A new vessel has HT 12. Used vessels (p. 190) may have lower HT.

cHP is the capacity of the hull to withstand damage. One cHP is 100 hit points. cHP = Total Area × F, where *F* is 60 for an extra-heavy frame, 30 for a heavy frame, 15 for a medium frame or rock hull, or 7.5 for a light frame or ice hull. Round to the nearest whole number. For vessels with combination hulls, calculate cHP for each hull.

cPF

This is the ability of the hull to protect against extremely high-energy penetrating radiation, including cosmic rays and particle beams. cPF depends on the mass of armor per ksf of area.

For manufactured hulls, refer to the *Materials Table* (p. 175), find *M* for the material used (e.g., 25 for steel alloy), and multiply that by the actual cDR. This gives the armor's tons/ksf. For asteroid hulls, multiply the cDR by 170 if rock or 230 if ice to get tons/ksf. Then look up cPF:

cPF TABLE

Tons/ksf	cPF	Tons/ksf	cPF	Tons/ksf	cPF
Under 50	1	500-599	100	1,100-1,199	10,000
50-99	2	600-699	200	1,200-1,299	20,000
100-199	5	700-799	500	1,300-1,399	50,000
200-299	10	800-899	1,000	1,400-1,499	100,000
300-399	20	900-999	2,000	1,500-1,599	200,000
400-499	50	1,000-1,099	5,000	1,600-1,699	500,000

Multiply cPF by 100 to get PF against solar radiation or planetary radiation belts.

Armor and PD

Record the cDR and cPF values for the spacecraft. Cylinders and boxes may have a different cDR value for each facing: Front (F), Back (B), and Sides (S).

If the vessel is a streamlined cylinder or delta, multiply front cDR by 1.4; for deltas, record separate F and B/S cDR and cPF values.

If it's important, passive defense (PD) of all faces is 4. Add +1 to the front PD of streamlined cylinders or deltas.

Maintenance Interval

Maintenance Interval is the time between maintenance checkups. Divide 20 by the square root of vehicle cost in M$ to get the Maintenance Interval in hours. Round to 2 places. If the vessel has a smart hull, then it is easier to maintain: *double* Maintenance Interval.

Each maintenance checkup requires 4 man-hours of labor. For spacecraft requiring frequent checkups, a more useful number is required maintenance in man-hours/day. This equals (96/Maintenance Interval) man-hours per day.

On a missed checkup, roll against the average Mechanic skill of the personnel who performed the last checkup, at -4 per missed interval after the first. Failure means the vehicle must roll vs. its HT or lose 1 HT. Critical failure means -1 HT and a serious malfunction (GM's option). Fixing lost HT is a "minor" repair; correcting a malfunction is a "major" repair (see *Repairs*, p. 190).

PERFORMANCE

A vessel has space performance values if it has a space drive. A streamlined lifting body can also fly and thus has an air performance.

SPACE PERFORMANCE

Calculate space performance values for each space drive (or combination of drives) the spacecraft is likely to use.

Space Acceleration (sAccel)

sAccel measures how rapidly the spacecraft can accelerate, and is rated in gravities (Gs). sAccel in Gs equals thrust in tons provided by all space drive systems used simultaneously, divided by CMass in tons. *Do not* include thrust from air-breathing engines. Round to 2 places.

RMC and Burn Endurance (Burn End.)

Reaction-Mass Consumption (RMC) is as calculated on p. 180. Burn Endurance in hours equals spaces of reaction mass in tanks divided by RMC. Note that if the vessel lacks sufficient radiators (p. 186), Burn Endurance will be limited by coolant endurance.

Burn Points

Burn points are used in tactical combat; one burn point represents sufficient reaction mass to accelerate for 100 seconds at 0.01 G. To find burn points, use this formula: Burn Points = 3,600 × sAccel × Burn Endurance (in hours). Round to nearest whole number.

Delta-V

This is the approximate maximum speed to which the vessel can accelerate using *half* its reaction mass, retaining the other half to decelerate. Delta-V is recorded in miles per second (mps). Delta-V (in mps) = sAccel (in Gs) × Burn Endurance (in hours) × 11.

Delta-V of plasma sails may not exceed 150 mps.

REALISTIC DELTA-V

For more realism, use this formula: Delta-V (in mps) = 0.003 × ISP × ln [Loaded Mass (in tons)/Dry Mass (in tons)]. The symbol "ln" means "natural logarithm"; a natural logarithm key, marked "ln," can be found on most calculators.

AIR PERFORMANCE

A streamlined delta lifting body has an air performance.

Stall Speed

Calculate Stall Speed as Square Root [4 × LMass (in tons)/Total Area (in ksf)] × Rs, where *Rs* is 13.5 mph if responsive structure, 18 mph otherwise. (Divide by 3,600 to get speed in mps.) Stall Speed varies on worlds other than Earth; multiply by the square root of local gravity and divide by the square root of local atmospheric pressure.

Air Speed

A streamlined delta may fly in atmosphere if its Air Speed exceeds its Stall Speed. First calculate drag: this equals Total Area/40 for most deltas and Total Area/48 for those with responsive hulls. Air Speed (in mph) = Square Root [15,000 × (Aerial Thrust/Drag)]. Round to the nearest 5 mph, then divide by 3,600 to get speed in mps.

The thrust of air-breathing engines can be added to aerial thrust in the above formula. Decide which other drives are used. Note that treaties prohibit the use of fusion or antimatter drives in Earth and Mars atmosphere, and fission air-rams in Earth atmosphere. Plasma sails do not function in atmosphere.

A spacecraft can make a runway takeoff if Air Speed exceeds Stall Speed and acceleration lets it reach Stall Speed before running out of runway.

SPACECRAFT OPERATIONS

Operating a spacecraft isn't cheap . . .

Reaction Mass and Fuel

Reaction Mass and Fuel: See *Reaction Mass, Coolant, and Fuel,* p. 187.

Antimatter: $1,000,000/gram.

Reactor Fuel

The reactors in some drives and power plants require occasional refueling.

Fission Drive: $160,000 of fissionable material (uranium, etc.) per space per 600 hours of continuous operation.

Nuclear Light Bulb: As fission drive, but per 1,200 hours of continuous operation.

Fission Reactor: $4,000 of fissionable material per MW of output per year; may be designed for up to 10 years or 40 years (using weapons-grade fuel). Refueling requires spaceyard maintenance costing 25% reactor cost.

New Fusion Reactor: 0.0000395 tons deuterium and 0.00059 tons helium-3 per MW per year.

Old Fusion Reactor: 0.00002 tons of deuterium per MW per year. Replace reactor shell and lithium jacket at 25% of reactor cost every 10 years.

Other Expenses

Mortgage Payments: Commercial spacecraft are usually financed with 10% down and a loan of 90%. Interest payments are 1% of the loan per month for 12 years. Payments over the 1% reduce the loan size, ultimately saving money.

Salaries: See the Job Table (p. 138). Many craft use unpaid infomorphs (or indentured bioroids).

Insurance: The usual premium is 10% of declared worth/year. If the vessel is lost or damaged, the insurance company pays, providing the loss cannot be traced to the owner's negligence or criminality, an act of war, etc. Brokers investigate major claims, which can postpone payment by months.

Buying It Used

Older space vessels (typically those with fission drives or plasma sails) are readily available used. The price break depends on how old the vessel is and its quality. The worse off the vessel, the lower its permanent HT score. In all cases, use the original, unmodified cost to calculate Maintenance Interval.

Fair Condition: Multiply cost by 0.9. HT 11.

Poor Condition: Multiply cost by 0.6. HT 10.

Terrible Condition: Multiply cost by 0.4. HT 8.

In addition, used vessels often come with unwanted "features." A Mechanic roll may be required to spot hidden defects. The GM may wish to apply bugs from pp. VE198-199, or just make up various problems. Perhaps the spacecraft's structure is infested with killer microbots, or the vessel is radioactive. Maybe there's an astropus hiding in the water tank, a set of mysterious coordinates laser-etched into the bottom of a chair, or a closet which conceals a mysterious body in nanostasis. Anything is possible!

Repairs

In a spaceyard, repair charges equal the cost of replacing all destroyed systems, plus 10%, plus half the cost of disabled items. It takes 50 man-hours of work and a roll against Mechanic skill to repair one cHP of damage; all normal modifiers apply (see p. B54). Treat this as a "minor" repair (no modifier) if the hull in question was not actually disabled (which occurs at 0 or fewer cHP), "major" otherwise (an extra -2 penalty). If a vessel has a smart hull, it is easier to fix: halve the time.

SPACECRAFT

Below are descriptions of some of the more common spacecraft in the ***Transhuman Space*** setting. See Appendix A for an explanation of design terms, statistics, and performance. Some additional notes:

Crew: These are standard crews rather than absolute requirements; some positions may be filled by cybershells or cyberswarms (which don't require cabins) – or a single highly skilled crew member may double up to perform multiple jobs.

Facing: This is noted parenthetically for armor, weapons, and fixed sensors. F is front, S is sides (combines right, left, top, and bottom), and B is back.

Size Modifiers: Two SMs are given for cylindrical hulls: the first is for width (vessel seen from front or back), the second is for length (seen from sides).

Delta-V: This was calculated using the simple formula (see p. 189).

KAGOSHIMA-CLASS ORBITAL TRANSFER VEHICLE

The *Kagoshima* was built by Tenzan Heavy Industries in 2069, and is one of many workhorse OTV designs. Its powerful fission drive (using water for reaction mass) is capable of lifting the vessel from the moon's surface into lunar orbit with a typical load of 95 tons of cargo and 32 passengers. It can carry an extra load on its external cradles (but performance is calculated with them empty). It has a spherical hull 40' in diameter. Usual payload is 98.1 tons. The *Kagoshima* spacecraft are named after spaceports.

Crew: Commander/Pilot/Navigator (Astrogation, Electronics Operation (Communications), Electronics Operation (Sensors), Piloting (High-Performance Spacecraft)); Steward/Cargo Master (Freight Handling, Savoir-Faire).

Design: Sphere hull (64 spaces, metal-matrix composite, light frame); cDR/cPF 1/1 (titanium alloy armor).

Modules: Old cockpit; small PESA; small radar; 1 compact fission drive (water reaction mass); 38 tanks (water); 0.1 battery; 2 passenger seats; 1 external cradle (250 tons); 19 cargo (95 tons).

Statistics: EMass 155; CMass 538; LMass 823. Cost M$11.58. cHP 38. Size Modifier +5. HT 12. Maintenance Interval: 5.88 hours. RRA 0.

Performance: sAccel: 0.23 G. Burn Endurance: 0.45 hours. Burn Points: 370. Delta-V: 1.14 mps. No air speed.

MEIZI-CLASS PSU

The *Meizi* was designed by MAST in 2089 and entered service with Mars Interplanetary in 2091. It is now the most common commercial "fastliner" in service with space carrier fleets. The craft has proven extremely adaptable.

The *Meizi's* hull is a 200' × 50' cylinder. It has two 114' spin arms with attached 31.25' × 50' pods mounted near the vessel's front (providing 0.38 G spin gravity). The design can carry 295 tons of cargo and has two 141' × 141' radiator wings. Standard payload is 331 tons. Typical names include *Meifeng* (beautiful phoenix), *Meiling* (beautiful jade), *Meiping* (beautiful peace), *Meisong* (beautiful song), and *Meizhen* (beautiful pearl).

Crew: Commander/Pilot (Leadership, Piloting (Low-Performance Spacecraft)); Navigator/Co-Pilot (Astrogation, Electronics Operation (Communications), Electronics Operation (Sensors)); Ship's Doctor (Diagnosis, Physician); Engineer (Administration, Mechanic (Fusion Drive), Mechanic (Robotics), other Mechanic as appropriate); Stewards (Diplomacy, First Aid, Savoir-Faire); Recreation (Erotic Art, Performance). Typically, the crew is mostly bioroids.

Design: [Hull] Cylinder hull (800 spaces, foamed alloy, medium frame); cDR/cPF 6/5F, 1/1S, 1/1B (aluminum alloy armor). [Pod #1 and #2] Cylinder hull (125 spaces, carbon composite, medium frame); cDR/cPF 2/5F, 2/1S, 2/5B (foamed alloy armor). Hull radiators (20 ksf), radiator wings (40 ksf).

Modules: [Hull] New basic bridge; medium PESA; medium radar; 120 HI fusion pulse drive; 600 tanks (nuclear pellets); 2.5-MJ light laser tower [S]; 2.5-MJ light laser tower [S]; 4 cabin; minifac workshop; small entry module; large entry module; surgery; spacedock hangar (20' long, 20' wide, 25' high; 20 spaces); 35 cargo (175 tons). [Pod #1] 25 luxury cabin; 50 cabin; 2 hall; 5 cargo (62.5 tons). [Pod #2] 100 cabin; surgery; 19 cargo (57 tons).

Statistics: EMass 3,682; CMass 7,613; LMass 11,213. Cost M$159.94. cHP [Hull] 540, [Pods] 135. Size Modifier [Hull] +6/+9, [Pods] +6/+5, [Radiators] +9. HT 12. Maintenance Interval: 1.58 hours. RRA 60.

Performance: sAccel: 0.06 G. Burn Endurance: 125 hours. Burn Points: 2,700. Delta-V: 82.5 mps. No air speed.

Pegasus-Class Transatmospheric Vehicle

Transatmospheric vehicles (TAVs) are rocket planes capable of reaching orbit or making hypersonic suborbital flights. They are streamlined lifting bodies that can fly to orbit and glide down for landings. Laser lift is more economical, but few spaceports have gigawatt lasers available. Manufactured by Vosper-Babbage, the *Pegasus* delta is the system's most popular medium-lift TAV. It has a 100' long delta hull (60' wide, 30' high). It carries 24 people and 5 tons of cargo (usual payload 8 tons). It will usually use all of its 798 tons of reaction mass to get into orbit (effectively doubling its Delta-V).

Crew: Pilot (Pilot (Aerospace)).

Design: Streamlined delta (64 spaces, nanocomposite, light frame, responsive, smart, lifting body); cDR/cPF 0.28/1F, 0.2/1S, 0.2/1B (nanocomposite armor).

Modules: New cockpit; small fixed PESA [F]; 3 compact kerosene-oxygen chemical rockets; 57 tanks (ultralight, kerosene-oxygen); 0.5 battery; 1.5 passenger seats; small entry module; 1 cargo (5 tons).

Statistics: EMass 49; CMass 455; LMass 854. Cost M$51.45. cHP 60. Size Modifier +8. HT 12. Maintenance Interval: 5.58 hours.

Performance: sAccel: 3.26 G. Burn Endurance: 0.059 hours (3.5 minutes). Burn Points: 690. Delta-V: 2.11 mps. Air Speed: 11,560 mph (3 mps). Stall Speed: 279 mph.

SIM-7 *Predator*-Class AKV

The Nanodynamics SIM-7 *Predator* is a high-end autonomous kill vehicle (AKV). It was designed in 2090, and is used by the USAF and some E.U. and PRA space forces, as well as Islandia. Other powers operate similar AKVs; e.g., China's *Zhengyang* ("righteous energy"). It has a 37.5' long by 10' wide streamlined cylinder hull with two folding 16' × 16' radiator wings. Usual payload is 9.5 tons (one munitions pack, either KKMP or XLMP).

Crew: Unmanned. Infomorph uses Astrogation, Electronics Operation (Communications), Electronics Operation (Sensors), Gunner (Railgun), and Piloting (High-Performance Spacecraft). Infomorph occupies the mainframe in the unmanned controls.

Design: Streamlined cylinder hull (6 spaces, nanocomposite, extra-heavy frame, smart hull); cDR/cPF 70/5F, 10/1S, 20/2B (nanocomposite armor). Hull radiators (1 ksf), folding radiator wings (0.5 ksf). Chameleon surface.

Modules: New unmanned controls; small fixed ladar [F]; small PESA; 1 coilgun bay [F]; 2.5 compact HT fusion pulse drive; 1.5 tanks (ultralight, nuclear pellets).

Statistics: EMass 82; CMass 100; LMass 109. Cost M$31. cHP 84. Size Modifier [Hull] +2/+5, [Radiators] +3. HT 12. Maintenance Interval: 7.18 hours. RRA 1.5.

Performance: sAccel: 0.3 G. Burn Endurance: 2.5 hours. Burn Points: 2,700. Delta-V: 8.25 mps.

Variant: The *Amazon*-class AKV is marketed by Liang Mountain and used by smaller space forces and independents. It is identical to the *Predator*-class except that the hull is not streamlined; frame and armor use metal-matrix composites with cDR/cPF 60/10F, 5/1S, 5/1B; and it has old unmanned controls. EMass 81. M$13.1. cHP 82. Maintenance Interval: 11.05 hours.

SDV-90 (*Resolution* and *Gram* Classes)

These space dominance vehicles (SDVs) resulted from a 2081 requirement to develop a common European Union SDV. After France went its own way, an Anglo-German team led by Vosper-Babbage and System Technologies A.G. completed the design in 2091. There have been 17 built so far, most serving with the Bundesraumwaffe and Royal Navy Space Service. Names used in Bundesraumwaffe service include *Balmung, Gram,* and *Tyrfing* (named for mythical swords), while those in RNSS service include the *Resolution, Respite,* and *Revenge.*

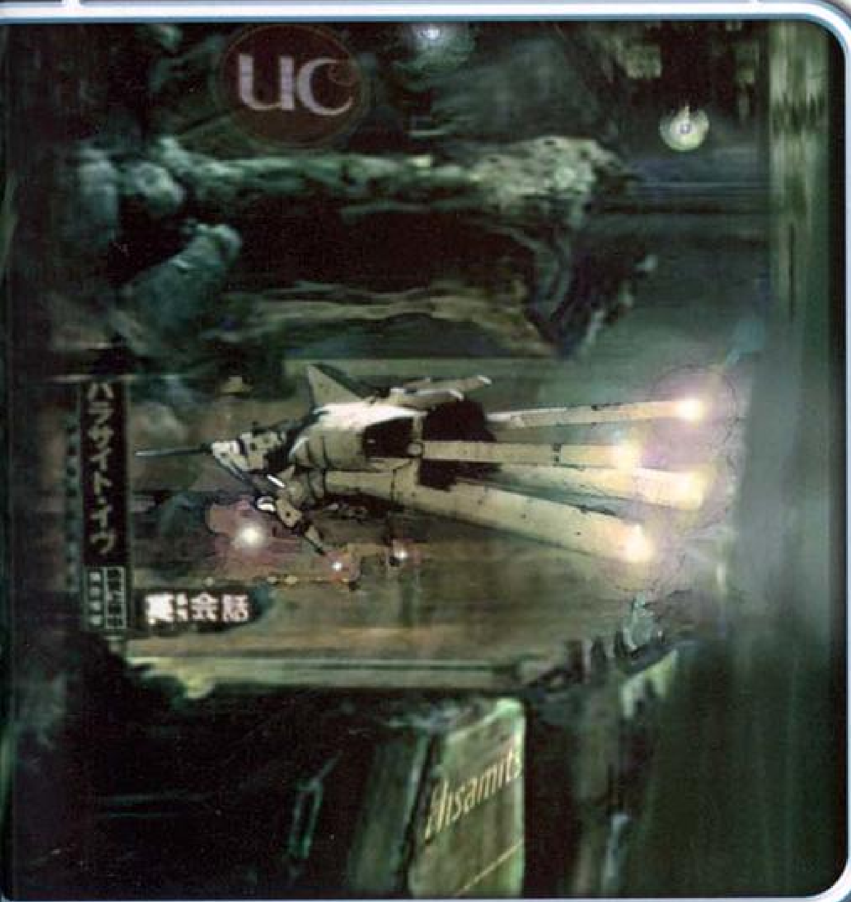
The SDV-90's hull is a bumpy cylinder, 375' long by 50' wide. A large spacedock is mounted in front, followed by the living quarters and bridge, multiple reaction-mass tanks, and a powerful fusion pulse drive. A particle accelerator runs the spacecraft's entire length, and the hull is studded with weapons, including eight 10-MJ laser towers. A pair of 274' × 274' radiator wings are usually extended, but can fold up if necessary. Its usual payload is 1,231.8 tons, including six *Predator* AKVs and 27 munitions packs; it can carry up to four more *Predators* or other small craft externally, at reduced performance.

Crew: Commander (Leadership, Shiphandling, Tactics); Pilot (Piloting (High-Performance Spacecraft)); Navigator (Astrogation, Electronics Operation (Communications), Electronics Operation (Sensors)); 3 Weapons Officers (Gunner (Beams), Gunner (Railgun)); 20 Engineers (Mechanic (Fusion Drive), Mechanic (Robotics), other Mechanic as appropriate); 2 Medics (Diagnosis, Physician, Surgeon). Often carries 12 battlesuit-equipped soldiers.

Design: Cylinder hull (1,500 spaces, metal-matrix composite, heavy frame, smart); cDR/cPF 55/10F, 5/1S, 16/2B (metal-matrix composite armor). Hull radiators (54 ksf), folding radiator wings (150 ksf). Chameleon surface.

Modules: New command bridge; 2 large ladar; 2 large PESA; 2 large radar; 375 HI fusion pulse drive; 750 tanks (ultralight, nuclear pellets); 8 10-MJ heavy laser towers [S]; 4 10-MJ heavy lasers [F]; 10 2.5-MJ light lasers [S]; 3 coilguns [F/S/B]; 350' new particle accelerator* [F]; 6 cabin; 2 passenger seats; 3 bunkroom; 1 heavy storm shelter (2-space: encloses bridge, cPF 1,000); 1 heavy storm shelter (2-space: encloses passenger seats, cPF 1,000); 4 external cradles (125 tons each); minifac workshop; large entry module; small entry module; spacedock hangar (75' long, 20' wide, 12' high; 36 spaces); surgery; 75 cargo (375 tons).

* While firing, can't use four heavy lasers.



Statistics: EMass 9,184; CMass 14,916; LMass 19,416. Cost M$810.91. cHP 1,920. Size Modifier [Hull] +6/+10, [Radiators] +10. HT 12. Maintenance Interval: 1.40 hours. RRA 187.

Performance: sAccel: 0.1 G. Burn Endurance: 50 hours. Burn Points: 18,000. Delta-V: 55 mps.

SUDBURY-CLASS USU

The *Sudbury* was built by Vosper-Babbage in 2072, and is a common sight in the solar system. It cannot land on most worlds, but its fusion pulse drive lets it make fast interplanetary passages. The *Sudbury's* hull is a cylinder 250' long by 50' wide, with two 77' × 77' radiator wings. Usual payload is 3,089.4 tons. Spacecraft are named after large meteor craters on Earth, such as *Chixulub, Mjolnir, Saint Martin,* and *Vredefort.*

Crew: Commander/Pilot (Leadership, Piloting (Low-Performance Spacecraft)); Navigator (Astrogation, Electronics Operation (Communications), Electronics Operation (Sensors), Gunner (Beams)); 5 Engineers (Mechanic (Fusion Drive), Mechanic (Robotics), other Mechanic as appropriate); Medic (Diagnosis, Physician, Surgeon); Cargomaster (Administration, Freight Handling). Many are cybershells.

Design: Cylinder hull (1,000 spaces, foamed alloy, heavy frame); cDR/cPF 5/2F, 1/1S, 5/2B (titanium alloy armor). Hull radiators (41 ksf), radiator wings (12 ksf). Liquid-crystal skin.

Modules: Old basic bridge; small ladar; medium PESA; medium radar; 100 HI fusion pulse drive; 250 tanks (nuclear pellets); 2.5-MJ light laser tower [S]; 13 cabin; 1 passenger seats; light storm shelter (2-space: encloses bridge and passenger seats, cPF 100); external cradle (125 tons); medium robot arm; minifac workshop; small entry module; surgery; 617 cargo (3,085 tons).

Statistics: EMass 3,372; CMass 7,961; LMass 9,461. Cost M$91.41. cHP 1,320. Size Modifiers [Hull] +6/+10, [Radiators] +7. HT 12. Maintenance Interval: 2.09 hours. RRA 50.

Performance: sAccel: 0.05 G. Burn Endurance: 62.5 hours. Burn Points: 1,125. Delta-V: 34.4 mps. No air speed.

NON-SPACECRAFT

AIR CAR

A streamlined, bubble-top flying car that uses hydrogen-burning ducted-fan turbines for lift and thrust. Seats four, small computer. Requires Piloting (Vertol) in flight, Driving (Automobile) on the ground. Accessories include an emergency parachute. 15' long, weighs 1,400 lbs. loaded. Has PD 3, DR 5, and 94 HP. Air speed is 400 mph for 4 hours. $100,000.

GROUND CAR

A typical battery-powered electric car. Seats five, small computer. Requires Driving (Automobile). 15' long, weighs 2,500 lbs. loaded. Has PD 3, DR 5, and 188 HP. Ground speed is 120 mph for 4 hours. $8,000.

APPENDIX C: SPACE COMBAT

"Captain, the bogie is now 16,000 kilometers from us, and has adjusted course to match our last burn."

"I knew it. They're Trojan Mafia, is what! Where's the nearest law?"

"Closest vector is a Chinese SDV, but she's 12 light-seconds away."

"Bogie still isn't replying?"

"Just their AI. It says it's the USV ***Serpent Mound,*** *a Duncanite farhauler out of Liang Mountain. Course correction was, quote, to avoid debris, unquote."*

"Yeah, right. Set the swarms for damage control and pop the laser tower. If we scare 'em off, maybe they'll go after easier meat."

The space-combat system presented here is derived from the one on pp. S133-144, but is optimized for the capabilities of ***Transhuman Space*** spacecraft. Movement is abstract; no board or map is required.

ENTERING COMBAT

Before any space action occurs, opposing forces must get within a few thousand miles of one another. The GM decides whether an encounter can take place, and if it is *close* or *distant.*

Close Encounters

These occur when the combatants begin within 1,000 miles of each other, and with low relative speeds. This may happen in a region such as Saturn's rings, the Lagrange points, or the space junk- and satellite-filled orbits around Earth, Luna, Mars, Mercury, or Phobos. Here, potentially hostile bases are often a few hundred miles apart and there are plenty of things to hide behind.

Close encounters can also occur when one side ambushes the other, such as a freighter that reveals itself as a pirate as it reaches an isolated station, or a hostile vessel that suddenly appears from behind another celestial body. Another example of a close encounter is when a spacecraft unexpectedly departs from a port and local craft or the port authorities attempt to stop it.

Distant Encounters

These typically take place between two vessels in deep space, thousands of miles from a celestial body or other vessels. PESAs can spot a craft hundreds of thousands of miles away, and encounters often occur at extreme relative speeds. There's little room for maneuver: spacecraft are lumbering beasts whose accelerations allow velocity changes of only a few feet per second, while speeds are measured in *miles* per second. Instead, both sides exchange increasingly deadly fire as they close. It's often over by the time they race into close-encounter range (and flash past). If not, then there is a good chance that kinetic-kill projectiles or ramming AKVs will be decisive, thanks to the high speeds involved.

DEFINITIONS

"Commander" refers to the entity controlling a particular vessel, while a "leader" is the overall commander of one side. A "vessel" can be a spacecraft, a station, or even a ground installation.

Space combat is fought in *space combat turns,* each representing 100 seconds.

Damage is in dice of *cDamage* (cDAM), with each point representing 100 hit points of damage. Armor is in *cDR* (units of 100 DR); hit points are in *cHP* (units of 100 hit points).

Burn Points

Burn Points represent a spacecraft's available reaction mass for tactical maneuvering. Once a close encounter begins, calculate Burn Points as 3,600 × original sAccel (in Gs) × Burn Endurance (in hours) remaining after any voyage. After a close encounter ends, convert remaining Burn Points back to Burn Endurance by dividing them by (3,600 × original sAccel).

CLOSE ENCOUNTERS

Distant encounters use a variation on these rules; see p. 201.

SURPRISE

At close-encounter ranges, detection is usually assured. However, it is possible that one side may surprise the other in some situations. For instance:

- In Earth orbit, a "commercial satellite" is revealed to be a disguised space-defense platform when it opens fire on a passing vessel.
- In L5, a spacecraft carefully maneuvers through a series of space colonies and habitats to mask its close approach to a target.
- In orbit around Saturn, an AKV rises from concealment behind a chunk of ring ice to attack a patrolling SDV.

- In deep space, a freighter with a supposedly malfunctioning drive opens fire on a good Samaritan as that vessel moves to dock with it.

The GM may rule that surprise does or does not take place on the basis of a roleplayed situation or a clever plan. In some situations, the GM may use a Quick Contest of Tactics (or Strategy, if a PC is commanding a large force), with modifiers based on the situation, to determine whether or not a target vessel falls for a ruse.

Those aboard a surprised vessel are at -4 (-2 for individuals with Combat Reflexes or Enhanced Time Sense) on all Gunner, Piloting, and Tactics rolls.

The effects of surprise usually last one turn. The GM may rule that some crewmembers take longer than that to reach crew stations if caught *totally* unaware.

TURN SEQUENCE

Each vessel takes its turn in sequence until they have all had a turn, then the sequence starts over – just as in personal combat.

On the first turn of combat, the side with the most vessels (roll a die if equal) picks one of the *enemy's* vessels to take its turn first. Then the other side picks one of the opposing vessels to take its turn. Alternate back and forth until all vessels have taken turns or one side runs out of vessels. If the latter occurs, then the remaining vessels may take their turns in whatever order their leader wishes. The GM should record the order in which the vessels took their turns (assign the first the number 1, the second the number 2, etc.). Retain this sequence, modified for losses, in all subsequent turns.

After everyone has acted, start a new turn, with surviving vessels acting in exactly the same order as before.

ACTION WITHIN THE TURN

On a vessel's turn, the following activities take place:

1. Maneuver. The vessel's commander picks a space maneuver, and chooses facing and expends Burn Points if required. Contests of Skill required by the maneuver are resolved. See *Space Maneuvers*, below.

2. Fire. The vessel's gunners may fire weapons; see *Beam and Gun Fire* (p. 197). Consult *Physical Damage* (p. 198) or *Radiation Damage* (p. 199), as applicable, to resolve damage.

3. Other Actions. The vessel's crew may perform repairs or active cooling, move about the vessel, and so forth; see *Other Actions* (p. 200). Collisions take place.

After this, the active part of the vessel's turn ends and the next vessel in the sequence takes its turn. However, the maneuver chosen by the vessel's commander is considered to remain in effect until the start of the vessel's next turn.

SPACE MANEUVERS

A commander must choose *one* of the following maneuvers. This will also affect his vessel's defenses if it is attacked before its next turn.

Facing: This is a vessel's facing relative to most enemy vessels. Depending on the maneuver, a particular facing may be required or the vessel's pilot may be allowed to choose it. For example, if your facing is "Front," then your front is pointed at the enemy vessels. Facing may be Front, Sides, Back, or Random (changing through the turn), and depends on the maneuver. Facing lasts until the vessel's next turn.

Burning: Some maneuvers require the vessel to spend Burn Points to receive a bonus (or reduced penalty) to skill rolls. The bonus is as follows:

BURN MODIFIER TABLE

Burn Points:	1	2	3	5	7	10	15
Bonus:	-2	0	+1	+2	+3	+4	+5
Burn Points:	20	30	45	70	100	150	200
Bonus:	+6	+7	+8	+9	+10	+11	+12

No vessel can spend more than 100 × sAccel Burn Points.

MANEUVER RESTRICTIONS

Attack Run: Cannot be made vs. an installation on a world with a very thin or denser atmosphere unless the maneuvering vessel has streamlining. Not allowed during a distant encounter until the close-encounter phase, or on the first turn of a close encounter unless surprise was achieved or the GM rules that the range is *exceptionally* short (under 100 miles).

Break Off: Only allowed if your last maneuver was Break Off or Evasive Action. Not allowed for a distant encounter until the close-encounter phase.

Ram: Restrictions as per Attack Run, but this maneuver can only be attempted if you were at short range to this target on your or the target's last turn.

Nonmaneuverable Vessels

A crippled or otherwise nonmaneuverable vessel (space station, no Burn Points, etc.) is limited to the Drift maneuver.

Surprised Vessels

Surprised vessels may only perform Drift or Hold Course maneuvers.

Attack Run

You choose a target (e.g., an enemy spacecraft, space station, or ground installation) and attempt to close to short range (under 100 miles) – or to maintain that range, if at short range already. Choose how many Burn Points to expend.

If your target is nonmaneuverable (p. 195), then your Attack Run is automatically a critical success. Otherwise, your target must decide whether to engage you or evade. If his last maneuver was an Attack Run or Ram against you, then he *must* engage; if it was Break Off or Evasive Action, then he *must* evade.

If your target chooses to engage, then roll a Quick Contest of Piloting skills. Add your Burn Modifier to Piloting skill. If your target made an Attack or Ram against your vessel on his last turn, then the enemy pilot adds his Burn Modifier from that maneuver; if not, then he is at -4. If you win, then you may choose the target's facing toward your attack this turn; the target retains its original facing vs. all other spacecraft. Win or lose, the vessels are now at short range. *Exception:* If both sides roll a critical failure, then your Attack Run inadvertently becomes a successful Ram!

If your target chooses to evade, then roll a Quick Contest of Piloting skills. Add your Burn Modifier to Piloting skill. If your target's last maneuver was Break Off or Evasive Action, then he adds his Burn Modifier from that maneuver; if not, then he is at -4. If you win, then the vessels are at short range; if you win by 4 or more, or via a critical success, then you also get to choose your target's facing toward your attack, as above. If you lose, then your Attack Run fails and the two vessels are at effective range (see *Weapons and Range,* p. 197).

Facing: Front to the target of your attack run (whether you succeed or fail) but Random to all other enemy vessels.

Burning: Spend at least 1 and up to 100 × sAccel Burn Points.

Break Off

You attempt to disengage from the close encounter. You leave the close encounter at the start of your next turn. However, any enemy vessels that close to short range or succeed at a Pursuit against you before then will escape with you. This forms a second close encounter some distance from the original.

If you Break Off, then you may still fire at other vessels in the previous encounter and be fired upon, but you are not subject to Attack Runs or Rams by those vessels and cannot make Attack Runs or Rams against them. *Exception:* if there's an object in the area to hide behind (such as an asteroid or a huge space station) or junk to lose oneself in (such as Saturn's rings, or the many colonies and satellites in Earth orbit, L4, or L5), then you may avoid further damage and escape completely from the battle.

Facing: Back.

Burning: Spend up to 100 × sAccel Burn Points.

Drift

A vessel taking the Drift maneuver is not using its drive, or has none.

Facing: Choose either Front, Sides, or Back, or if non-maneuverable, Random. *Exception:* If nonmaneuverable during a distant encounter, your facing may be set by the GM and will usually remain the same from turn to turn.

Burning: None.

Evasive Action

You maneuver cunningly or violently to avoid enemy Attack Runs or Ram attempts, or to vary your facing.

Facing: Random.

Burning: Spend at least 1 and up to 100 × sAccel Burn Points.

Hold Course

You maneuver to maintain a constant facing to the enemy, or to perform other actions. This is a prerequisite for docking with another vessel. A vessel must also Hold Course while it is reentering atmosphere, landing, or taking off (multiply time required in hours by 36 to get turns).

Facing: Choose either Front, Sides, or Back (Front if taking off, Back if landing – reversed to anyone on that world or below you).

Burning: 1 Burn Point, plus the cost of any takeoff or landing.

Pursuit

You attempt to follow a vessel that is trying to flee the encounter. Choose a target vessel whose last maneuver was either Break Off or a *successful* Pursuit. Roll a Quick Contest of Piloting skills. Each vessel adds its Burn Modifier. You add +3 if you performed a successful Attack Run against that target on the previous turn.

If you lose, then your opponent will escape when he breaks off. If you win, then your Pursuit succeeds; your opponent breaks off from the main encounter, but you (and any other vessels that have successfully pursued) follow him, starting a new encounter lateral to this one; see *Break Off* (p. 196).

Facing: Front vs. the target you are pursuing, Back vs. all other enemy vessels.

Burning: Spend at least 1 and up to 100 × sAccel Burn Points.

Ram

You attempt to collide with a target vessel. Your attempt is treated as an Attack Run, except as follows: if you win the Quick Contest by more than (16 - target's Size Modifier) and at least by 1, or with a critical success, then you collide with your target at the end of your current turn. If you succeed by a lesser margin, then your Ram is treated merely as a successful Attack Run.

Facing/Burning: Per *Attack Run* (p. 196).

BEAM AND GUN FIRE

A vessel may fire some or all of its beam and gun weapons once its maneuver is resolved. Each weapon may fire at a target once per turn, if facing and range permit.

A target vessel must be specified for each weapon fired. If the vessel has multiple hulls, exposed radiator wings, or craft in external cradles, then these can be specified as targets instead of the main hull. Radiator wings can only be targeted if the enemy's side is facing the firing vessel.

Coilguns firing KKMP are not aimed at a specific part of the target vessel. Instead, they do damage against *all* of the following targets simultaneously: exposed radiator wings (from the side), all external vessels, and all hulls.

Coilguns are limited by ammunition, consuming one munitions pack (XLMP or KKMP) per 10 shots, and may not fire if no munitions are available.

Weapons and Facing

A firing vessel's facing toward an enemy governs which weapons can fire: Front [F] weapons if the facing is Front, and similarly for Sides [S] and Back [B]. Tower weapons and coilguns firing XLMP can fire at targets regardless of facing. If the firing vessel's facing is Random, then roll 1d for its facing toward its enemies as it fires: 1 = Front, 2-5 = Sides, 6 = Back.

Weapons and Range

The range between two vessels may be *short* (up to 100 miles), *effective* (101-2,500 miles), *long* (2,501-6,000 miles), or *extreme* (6,001-8,500 miles). The range between your vessel and its target is normally *effective* unless:

- Your vessel performed an Attack Run or Ram this turn which took you to short range with that target.
- Your vessel performed a Drift this turn, and your target's last maneuver resulted in it closing to short range with you.
- It is the opening or closing phase of a distant encounter (p. 201), in which case range may vary from effective to extreme.

In some surprise situations, the GM may rule that range is automatically short; e.g., a vessel suddenly attacking an allied craft that is docked with it.

Gunnery

Laser, particle, and X-ray laser beams travel at relativistic velocities and *cannot miss* at ranges of a few thousand miles or less against the slow-accelerating craft of ***Transhuman Space.*** The swarm of submunitions fired by a coilgun using KKMP is also difficult to avoid at short range, but can be dodged automatically at any greater range.

However, proper aim can increase damage by coordinating fire and aiming at weak points. A gunner firing a weapon or multiple weapons at a particular target makes a *single* Gunner (Beams) roll for all beam weapons fired and a *single* Gunner (Railgun) roll for all coilguns fired at that target. This roll is adjusted as per *Gunner Modifiers* (see p. 198).

WEAPON RANGES

Coilgun, Firing KKMP: Can fire at targets at short range.

Coilgun, Firing XLMP: Can fire at targets at short or effective* range.

Laser, Light: Can fire at targets at short, effective, or long* range.

Laser, Heavy: Can fire at targets at short, effective, long, or extreme* range.

Particle Accelerator, 50' Tube: Can fire at targets at short range.

Particle Accelerator, 100-200' Tube: Can fire at targets at short or effective* range.

Particle Accelerator, 250-400' Tube: Can fire at targets at short†, effective, or long* range.

* *Halve* damage at this range.

† *Double* damage at this range.

GUNNER MODIFIERS

Firing Vessel's Sensors: +1 for each sensor *type* (ladar, PESA, radar) possessed. Small sensors do not provide a bonus at long or extreme range; medium sensors do not provide a bonus at extreme range. If a vessel has multiple sensors, use the ones that give the best bonus at current range. Fixed sensors do not count if they are not facing the enemy (as per weapon facing). If no sensors face the enemy, then the vessel may not fire!

Gunner with Multiple Targets: -1 per target after the first, if the gunner is firing multiple weapons at different targets. E.g., if the gunner controls six weapons and fires four at one vessel and two at another, then he suffers a -1 penalty on both attack rolls. This is why vessels have multiple weapons officers!

Multitasking: See *Crew Actions and Multitasking* (p. 202).

Target's Maneuver: -3 if Evasive Action, +3 if Drift.

Critical success doubles damage dice; e.g., 2d×5 becomes 4d×5. Success means the fire is properly coordinated; no modifiers apply. Failure means the fire is poorly coordinated and not properly held on target to penetrate armor; the target's cDR is multiplied by the margin of failure, but always at least doubled, to a maximum of 10 × cDR. Critical failure means the target's cDR is multiplied by 10.

Roll damage for each weapon to determine the results of its fire; see *Physical Damage* (below) for lasers and coilguns, *Radiation Damage* (p. 199) for particle accelerators.

> **There are three types of spacecraft – SDUs, AKUs, and targets.**
> **– Captain Phillipe Lacroix, Force Aerospatiale**

PHYSICAL DAMAGE

Lasers, coilguns, and ramming inflict physical damage. The effects depend on whether the target's hull or radiator wings were attacked, and the weapon used. (Note that KKMP attacks both the hull and radiator wings.)

Laser Damage

Laser damage represents a full 100 seconds of laser fire, with the gunner attempting to focus the laser on a particular area to penetrate armor. XLMP damage represents the launch of several packages, each housing a nuclear-pumped "Teller mine" that discharges multiple X-ray laser beams.

Light Laser: cDAM is 2d×5 at short or effective range, halved to 1d×5 at long range.

Heavy Laser: cDAM is 2d×10 at short, effective, or long range, halved to 2d×5 at extreme range.

XLMP: cDAM is 4d×5(2) at short range, halved to 2d×5(2) at effective range; (2) means target cDR is halved.

Ramming and KKMP Damage

Ramming: Each vessel involved in the collision takes cDAM equal to 3d times the cHP of the ramming vessel or the target, whichever is *lower,* multiplied by *RV.*

KKMP: KKMP munitions fire a shotgun-like barrage of kinetic-kill submunitions. The target vessel is hit a number of times equal to half its Size Modifier, round up (minimum 1). cDAM is 1d×RV *per hit.*

RV is 1 for ramming or 2 for KKMP, plus 1 per 1,800 Burn Points used during the Attack Run or Ram maneuver of the attacking vessel. In a distant encounter (p. 201), add 2 per mps of relative velocity.

Physical Damage to the Hull

Hull armor is rated for its cDR vs. physical attacks. Subtract hull cDR from rolled damage to find penetrating damage. Note that cDR may vary by facing; see *Armor and Facing.*

If the attack is a coilgun firing XLMP, then halve the target's cDR (round down). If the attack is KKMP, then multiply cDR by the target's Size Modifier (minimum 1, maximum 10). If the attack roll failed, then multiply cDR

ARMOR AND FACING

Vessels sometimes have different armor on different locations. The location struck depends on the *target's* facing rather than your own.

If the target's front faces the attacker, then its hull front armor (F) is hit.

If the target's sides face the attacker, then its hull sides armor (S) is hit.

If the target's back faces the attacker, then its hull back armor (B) is hit.

If the target's facing is Random, then roll 1d for its facing toward each attacking vessel that fires on it: 1 = Front, 2-5 = Sides, 6 = Back.

by the margin of failure (minimum 2, maximum 10), treating critical failure as failure by 10.

Damage Multiplier: Laser and XLMP damage represents multiple hits over a 100-second turn. Damage that penetrates hull cDR is multiplied by 2.

Effects of Hull Damage

Damage that penetrates the hull's cDR is subtracted from its cHP.

Major Damage: Each time cumulative damage to the hull reaches a full multiple of 10% of the hull's cHP, roll on the *Major Damage Table* (p. 203).

Badly Damaged: If the hull containing the vessel's space drive is reduced to less than half its cHP, but still has positive cHP, then the vessel's sAccel is halved (round down).

Disabled: If hull cHP drops to 0 or less, then the hull is disabled; it is crippled, out of power, and leaking air. If it contains the vessel's space drive, then the vessel's sAccel drops to 0. Systems (communicators, computers, sensors, weapons, etc.) installed in that hull cease to function. Vehicle bays or spacedocks may work; a particular spacedock or vehicle bay functions on a roll of 1-3 on 1d.

Destroyed: If a hull is reduced to -5 × its starting cHP or less, it is destroyed. It loses structural integrity and breaks up. Occupants are now scattered through space, along with other debris, and each takes 5d-5(10) damage.

Hull Surface Hits

Vulnerable surface installations such as laser mirrors or hull radiators may be damaged by weapons fire even if the attack fails to penetrate armor. Each roll of 1 or 6 on the dice for laser, XLMP, or KKMP damage has an additional effect:

Each 1 rolled means one of the target's lasers or laser towers (if any) was disabled, provided it could attack the firing vessel. For example, if the target's front faces the firing vessel, then only its front lasers could be disabled. If no weapons qualify, then none are affected. The attacker chooses which weapons are disabled.

Each 6 rolled means the target loses one ksf of hull radiator area (up to a maximum of the radiators remaining on that hull).

When rolling damage given as (for example) 2d×10, be sure to roll only 2d and multiply the result by 10, rather than rolling 20d. The latter would give an unintended 10-fold increase in the number of surface hits!

Damage to Exposed Radiator Wings

These have no cDR or cHP, but if they are deliberately attacked, then every three full points of damage disables one ksf of exposed radiator wing area. A vessel may not lose more ksf of wing radiators from a single attack than its original radiator wing area divided by its number of radiator wings.

Exposed solar panels may be attacked and damaged in the same way, but are even more vulnerable: each point of damage disables one ksf of panel.

RADIATION DAMAGE

Particle accelerators spray a cone of deadly radiation. Compare the particle accelerator's tube length to the target hull's cPF (which may vary by facing; see *Armor and Facing,* p. 198) on the *Particle Accelerator Damage Table,* and then roll the indicated dice of radiation damage. This is the total exposure in rads experienced by all occupants and systems not in storm shelters.

If the target vessel has crew or systems protected by a higher cPF – for instance, a light storm shelter (cPF 100) or a heavy storm shelter (cPF 1,000) – then roll damage separately for the protected people and systems. PF from suits has no effect on the radiation from particle-accelerator attacks.

Keep track of the cumulative total rads sustained by the vessel, tracking any systems protected by storm shelters separately. Each time a cumulative 4,000 rads are taken, roll 1d for *each* coilgun, control system (bridge, cockpit, or unmanned controls), drive, laser, particle accelerator, power plant (if separate from the drive), and sensor. On a 6, the system is disabled. The GM may also check for radiation damage to other, less crucial systems (such as minifac workshops) after the battle is over.

For effects on cybershells (including bridge and cockpit computers) and living things, see *Radiation* (pp. 59-60).

Particle Accelerator Damage Table

cPF	*50' tube*	*100' tube*	*150' tube*	*200' tube*	*250' tube*	*300' tube*	*350' tube*	*400' tube*
1	1d×200	1d×1,000	2d×1,000	4d×1,000	6d×1,000	9d×1,000	12d×1,000	8d×2,000
2	1d×100	1d×500	2d×500	4d×500	6d×500	9d×500	6d×1,000	8d×1,000
5	2d×20	2d×100	2d×200	4d×200	6d×200	9d×200	12d×200	16d×200
10	1d×20	1d×100	2d×100	4d×100	6d×100	9d×100	6d×200	16d×100
20	1d×10	1d×50	2d×50	4d×50	6d×50	9d×50	6d×100	8d×100
50	4d	2d×10	2d×20	4d×20	6d×20	9d×20	12d×20	16d×20
100	2d	1d×10	2d×10	4d×10	6d×10	9d×10	12d×10	16d×10
200	1d	1d×5	2d×5	4d×5	6d×5	9d×5	12d×5	16d×5
500	1d-2	2d	4d	4d×2	6d×2	9d×2	12d×2	16d×2
1,000	1d-3	1d	2d	4d	6d	9d	12d	16d
2,000	1d-4	1d-2	1d	2d	3d	4d+1	6d	8d
5,000	none	1d-3	1d-2	1d-1	1d+2	2d	2d+1	3d+1
10,000	none	1d-4	1d-3	1d-2	1d-1	1d	1d	1d+2

OTHER ACTIONS

A vessel may perform a variety of actions at this stage. As well, it may overheat if it lacks deployed radiators.

Damage Control

cHPs cannot be repaired during a space combat turn, but disabled computers, lasers, radiators, and sensors, and the results of Major Damage, can be repaired by people, cybershells, or appropriate cyberswarms.

Only one roll is allowed per system, regardless of the size of the repair team assigned to the task. Modifiers: a base -4, with +1 for 2 mechanics, +2 for 3, +3 for 4-6, +4 for 7-9, and +5 for 10 or more. Use the *average* skill level, rolling against Armoury skill to repair weapons and Mechanic skill to fix radiators or other Major Damage. Note that 10 hexes of cyberswarm count as one mechanic. Each minifac aboard gives *one* repair team a +1 bonus; a factory or robofac gives *all* teams a +2 bonus.

Success means the item has been jury-rigged and will work for a number of turns equal to the margin of success, minimum one turn. A critical success means it is as good as it was before. Failure means it is still broken, but repairs can be attempted in later turns. Critical failure means it cannot be repaired and must be replaced (taking a few days and possibly spare parts).

If a system has already been disabled once, repaired, and disabled again, then there is a cumulative -3 penalty on further repair attempts.

Docking and Launch

Two friendly vessels may dock (i.e., one vessel may enter an external cradle, spacedock hangar, or vehicle bay on the other, or the vessels may match courses and mate airlocks) if they both took a Hold Course maneuver or one took Hold Course and the other Drift.

Vessels with external cradles, spacedock hangars, or vehicle bays may launch any or all smaller craft (if room allows) in the "other actions" phase of their turn.

The performance of vessels which pick up or launch other vessels may be altered; it's up to the GM whether to bother with this recalculation.

Extending/Retracting Systems

A vessel with retractable radiators may extend or retract them, affecting its Deployed Radiator Area (see *Overheating and Powering Down*) for its *next* turn. Solar panels may also be extended or retracted, as may laser towers. While retracted, retractable systems cannot be used but are not subject to surface damage.

Overheating and Powering Down

Vessels are normally designed to avoid overheating, but combat may damage radiators, and vessels may retract them to avoid damage. If so, then overheating may occur.

A vessel's *Deployed Radiator Area* (DRA) is the sum of hull radiator area plus wing radiator area. This may be reduced by damage to radiators. If a vessel has retractable radiator wings, then wing radiator area is not counted on any turn during which the wings are retracted.

A vessel accumulates Heat Points each turn equal to its Required Radiator Area (RRA) minus its DRA. It may use active cooling to reduce this.

Active Cooling: A vessel with tanks of water, ice, or reactor coolant may use them to reduce Heat Points. A vessel can eliminate two Heat Points by using up one space of water or four Heat Points by using up one space of reactor coolant. (Fractional values are possible.) It can eliminate one Heat Point by melting four spaces of ice, turning it into four spaces of water.

If the vessel relies on water reaction mass, then it can use water as both coolant and Burn Points. Each space of water expended as coolant uses up (total Burn Points/total spaces of water in tanks) Burn Points.

Overheating: If a vessel ends a turn with more Heat Points than 4 × RRA, then it has overheated. An overheated vessel must power down to vent heat (see below). It can be restarted on the *next* turn after its Heat Points drop below 4 × RRA, or it may remain powered down to vent more heat.

Powering Down: A vessel may be forced to power down due to heat (see above). It may also *voluntarily* power down at the end of any turn on which it chooses a Drift maneuver. Powering down involves shutting down all drives and all power systems other than energy banks. A powered-down vessel does not accumulate Heat Points. Instead, it *sheds* Heat Points equal to its DRA or 1, whichever is greater. A powered-down vessel cannot fire weapons.

DISTANT ENCOUNTERS

A battle is only likely if the combatants are on a converging course or if one side is faster than the other. The GM can allow Electronics Operation (Sensors) rolls specifically to identify detected targets by processing sensor data; see *Sensors* (p. 178) for detection ranges. Traffic-control personnel typically begin to query incoming spacecraft as to their intentions when they get within roughly one light second (186,000 miles) – especially if the inbound craft is an unscheduled flight.

The GM should determine the speed and course of the vessels involved. This will depend on the situation (see *Space Travel,* p. 52): a vessel coasting to Ceres at 20 miles per second (mps) has that speed, while one that has just started burning to leave orbit has that world's "to orbit" velocity. If one side is arrayed around a particular point (in orbit, etc.) on which the other closes, then relative speed is the speed of the inbound side. If one side is chasing another, then it's the difference in their speeds. If two sides are converging on the same point from opposite or nearly opposite angles, it's the sum of their speeds, etc.

Each side will have roughly T = (D/RV)/3,600 hours to prepare before the enemy comes into range, where *D* is the difference in miles between the distance at which they became alarmed and extreme range, and *RV* is the relative (closing) velocity in mps.

Each side can use up to *T* hours of Burn Endurance to increase or decrease its own speed to alter the final relative velocity. Maximum change is B × A × 11 mps, where *B* is the Burn Endurance used (in hours, up to a maximum of *T*) and *A* is sAccel in G. If relative velocity goes "negative" as a result, then no encounter will take place.

The above calculations assume that a multi-vessel force is limited by its slowest vessel; thus, a force protecting a space station can't change relative velocity. Situations where forces break into multiple groups are possible. In general, this will result in part of one side being engaged earlier, or not at all.

Fighting Distant Encounters

Pre-Battle Turn: Play out one turn before the vessels get into range. This lets vessels establish facing, launch small craft, extend or retract radiators, etc. Use the close-encounter rules, but no Attack Run, Break Off, or Ram maneuvers are permitted, and no firing is allowed.

Firing: Once the combatants get within 8,000-9,000 miles of each other, combat can occur. It falls into three distinct phases:

1. Distant Closing Phase: During this phase, use the close-encounter rules with no Attack Run, Break Off, or Ram maneuvers permitted. The first 25/RV turns are at extreme range, the next 40/RV turns are at long range, and the last 15/RV turns are at effective range. (Note that if neither side has heavy lasers, then the first 25/RV turns at extreme range can be ignored.)

2. Close-Encounter Phase: This lasts 10/RV turns. Use normal close-encounter rules.

3. Distant Opening Phase: As opening phase, but inverted: the first 15/RV turns are at effective range, the next 40/RV turns at long range, and the final 25/RV turns at extreme range.

When calculating numbers of turns, round fractions of 0.5 and larger up. If multiple groups are involved at different RVs and distances, then the GM should keep track of each. This can rapidly get complex; feel free to simplify or fudge! If one side defeats the enemy, it may still need to spend some of its Burn Endurance to reduce its final speed.

SPECIAL RULES

These rules cover special situations that may arise in space combat.

Antimatter

When a vessel carrying antimatter is disabled, so are its containment fields. Containment will fail – catastrophically – without speedy repairs. Repairs use the rules under *Damage Control* (p. 200); however, the repair team takes 1d×1,000 rads. At the end of each turn on which containment remains disabled, roll 3d. On 16 or less, containment fails. If the vessel is destroyed, containment fails automatically. A vessel can also voluntarily release its antimatter.

Containment failure (or voluntary release) results in a massive explosion; cDAM is 12d×250,000 (averaging 10,500,000) *per gram of antimatter.* cDR does not protect the vessel itself. Assume that other vessels (even at short range) are far enough away that damage is nil unless they were ramming or docked with the exploding vessel. If so, then they take full damage; however, multiply cDR by 100, square it, and divide by 100 to get the effective cDR vs. the blast. Radiation damage (rads) is equal to the damage rolled divided by 100 × cPF. *Exception:* if a vessel rammed or was rammed, subtract ram damage from cDR (to a minimum cDR of 0) before calculating armor protection.

Crew Actions and Multitasking

Large crews may have an individual (human, infomorph, etc.) assigned to each task, but smaller vessels must sometimes double up particular jobs. Once combat begins, the following activities require individual attention:

Piloting: A vessel performing any maneuver other than Drift requires a pilot. He chooses the vessel's maneuvers, selects the vessel's facing, expends Burn Points, and chooses the targets of Attack Run and Ram maneuvers. Use his Piloting skill in Quick Contests stemming from maneuvers.

Gunnery: A vessel firing weapons requires at least one gunner. A single person can act as the gunner for multiple weapons (at a penalty to skill; see *Gunner Modifiers,* p. 198), or this task can be divided among multiple gunners. A gunner chooses targets for his weapons, makes Gunner skill rolls and damage rolls for those weapons, and may extend or retract any laser towers under his control.

Engineering Control: A vessel needs someone assigned to engineering control in order to power up, voluntarily power down, use active cooling, or extend or retract radiators or solar panels. In the absence of such a crewman, these options are unavailable.

Damage Control: A crewman can only perform damage control (p. 200) if he did not perform other tasks (piloting, gunnery, engineering, etc.) this turn.

Communications: Communicating with other vessels only counts as a distinct task if it requires someone's full attention: coordinating operations for an entire squadron, conducting negotiations, etc.

Command: A vessel with a large crew will usually have a commander. He may order pilots to perform specific maneuvers, gunners to engage particular targets, damage-control teams to repair certain systems, etc. Of course, he may have to make Leadership rolls to get his crew to follow orders!

Crewmen who are busy with non-combat duties (whether it is looking after frightened passengers or providing medical aid) can't perform the above tasks.

The Command, Communications, Engineering Control, Gunnery, and Piloting tasks can be done simultaneously, but with a -2 penalty per task after the first. For example, someone who is both giving orders to other crew and firing weapons takes a -2 on Leadership and Gunner rolls.

Ice Armor

The cDR of ice armor is reduced by 1 on the location struck for every 5 points (front or back) or 20 points (sides) of cDAM inflicted by laser fire, whether the damage penetrated or not.

Orbital Strike

Weapons in space can be fired against ground targets. However, thick atmosphere gives some protection. The GM should assign cHP and cDR to ground installations.

KKMP: Full effect on ground targets. Anything within 300 yards of the primary target will also be hit.

Laser: Add cDR 10 × Pressure (in Earth atmospheres). On Earth and Mars, if the target area is overcast, then add +1 (Mars) or +2 (Earth) to cDR.

Particle Accelerator: The particle beams used for space combat cannot reach the surface of Earth, Mars, Titan, Venus, or a gas giant due to the radiation protection provided by their thick atmospheres.

XLMP: X-ray lasers cannot penetrate atmosphere at all.

Weapons fire from surface to orbit has the same limitations, but coilguns cannot be used if the world has an escape velocity of 0.5 mps or more.

Spotting a ground target may be harder than hitting it. Radar can see through clouds, but PESA and ladar cannot. Precise identification of targets is difficult without a ground spotter (see *Forward Observer,* p. CI151).

Point Defense Fire

Lasers are normally assumed to be focused on a single target for the entire turn. However, a gunner may assign a light or heavy laser to "point defense" mode. This is useful if multiple ram attempts are expected.

If a laser is in point defense mode, then it does not fire on the vessel's own turn. However, until the vessel's next turn, it will *automatically* fire upon any target that makes a successful ram attack against the vessel. Resolve damage before the ram. If it disables or destroys the incoming vessel, then no ram takes place.

A weapon firing in point defense mode may fire multiple times if subject to multiple rams, but each firing after the first has a cumulative -1 damage per die.

Make Gunner skill rolls normally for each individual point defense fire.

MAJOR DAMAGE TABLE

Each time cumulative damage to the hull reaches a full multiple of 10% of the hull's cHP, roll on the table below.

3 – Energy bank damaged: lose 50% of stored energy in hull. If there is no energy bank, treat as #12.

4 – Occupant injury: one of the vessel's occupants is injured or killed (see below). *Exception:* if over 50 people occupy the hull, then 1% are affected (minimum 1 person). If there are no occupants, treat as #10.

5 – Drive damaged: halve sAccel. If the vessel has no drive, treat as #4.

6 – Cargo damage: 25% of current cargo in hull is lost. If there is no cargo, there is no effect.

7 – One sensor knocked out. If there are no sensors, treat as #4.

8 – One accessory (surgery, workshop, etc.) is knocked out. If there are no accessories, treat as #4.

9 – Occupant injury; see #4.

10 – Weapon damaged: largest weapon is disabled (GM's option). If the vessel has no weapons, treat as #6. This is the only way coilguns and particle beams are damaged.

11 – No special effect.

12 – Tank shattered: 25% of present fuel or reaction mass is lost. Multiply current Burn Points by 0.75. If the vessel has no tanks, treat as #6.

13 – Occupant injury; see #4.

14 – Drive damaged; see #5.

15 – Spacedock hangar or vehicle bay damaged: door cannot be opened/shut. If the target has no docks or bays, treat as #6.

16 – Bridge, cockpit, or unmanned controls knocked out. Vessel is crippled unless it has a backup. Anyone in the bridge or cockpit takes 5d(10) damage.

17 – Life support damaged: loses 10% of original capacity. No effect in combat (assuming occupants have vacc suits), but may cause problems later.

18 – Power plant knocked out: lose highest-output plant. If the target has no power plant, treat as #5.

Any time a result could describe multiple systems, roll randomly to see which one is affected. Power loss may force systems to shut down – see Appendix A for system power requirements.

Occupant Injuries: The GM can determine who is affected randomly, or choose based on dramatic considerations. Minor NPCs can be assumed to be either dead or disabled. PCs and important NPCs take 5d(10) damage. Treat cybershells as occupants, but ignore swarms and anything much smaller than a human unless it is vital; they can also suffer losses proportional to the human-sized crew.

GLOSSARY

The following specialized terms are used in the *Transhuman Space* setting.

JARGON

artificial intelligence (AI): A computer program capable of intelligent behavior.

augmented reality: The use of virtual reality and wearable or implanted computer interfaces to overlay data on normal sensory perceptions.

biogenesis: Assembling a living thing using NANOTECHNOLOGY.

biometrics: The use of scanned physiological characteristics, such as DNA, the face, and finger-, voice-, and retina prints, for identification.

biomod: A biological modification added to a being after conception and (usually) after birth; e.g., NANOSYMBIONTS or a transplanted enhanced organ.

bioroid: A living humanoid that is assembled using BIOGENESIS.

bioshell: A biological body controlled by an INFOMORPH.

bush robot: A CYBERSHELL whose "fingers" branch into ever finer and smaller manipulators.

Complexity: Abstract rating of computer processing power. Each level represents a roughly tenfold increase.

cryogenic: Very cold; below -238°F.

cybershell: A physical body, larger than a MICROBOT, housing an INFOMORPH or capable of being teleoperated. Cybershells include various ROBOTS and computers.

decerebrate: Lacking higher brain functions.

deep space: Space beyond a planet's or moon's orbit.

delta-v: Velocity change; typically, the maximum speed a spacecraft can attain before exhausting its supply of reaction mass.

downslink: A brain implant that translates a digital copy of a person's sensory experience back into a form that a human brain can perceive.

emag: Electromagnetic (gun).

eugeneering: Eugenic genetic engineering; the careful selection of specific traits to improve a species or correct defects.

exowomb: An artificial womb; a womb tank.

farhauler: A DEEP SPACE transport vessel, or one of its crew.

fastliner: A passenger spacecraft capable of rapid interplanetary journeys using fusion drive.

fauxflesh: Artificial, vat-grown meat.

fragment: An incomplete MIND EMULATION.

genefixed: A person born following a GENEFIXING process.

genefixing: EUGENEERING to fix hereditary defects or flaws.

genemod: Genetically modified.

gengineering: Genetic engineering.

genetic upgrade: EUGENEERING aimed at improving a person.

ghost: A MIND EMULATION program of an uploaded (human) personality.

HyMRI: Hypersensitive Magnetic Resonance Imaging.

infomorph: An AI or MIND EMULATION; a digital intelligence.

inner system: The solar system from the sun out to the orbit of Mars.

InVid: Interactive Video, a popular form of mass media.

Lagrange Point: Stable gravitational points created by the interaction of the Earth and the moon. L4 is 60° ahead of Luna's orbit; L5 is 60° behind it.

light-second: The distance light can travel in one second: 186,000 miles, 300,000 kilometers, or 1/500 AU.

Main Belt: The asteroid belt between the orbits of Mars and Jupiter. (Sometimes known as simply "the Belt.")

meme: The cultural analog of a gene. An idea, behavior, story, advertisement, or other concept that propagates from one person to another.

memetic: Pertaining to MEMES.

microbot: An insect-sized or smaller ROBOT.

mind emulation: An INFOMORPH that is a digital copy of a human mind; a FRAGMENT, GHOST, or SHADOW.

nano: Pertaining to NANOTECHNOLOGY. Also, NANOMACHINES.

nanobot: A cell-sized or smaller ROBOT. Most nanobots are engineered life forms rather than mechanical robots.

nanofactured: Manufactured using NANOTECHNOLOGY.

nanomachine: A NANOBOT or other cell-sized machine.

nanosocialism: A popular ideology advocating the ownership of patents, copyrights, and other information by the public rather than individuals.

nanostasis: A form of suspended animation.

nanosymbionts: NANOBOTS that perform beneficial services (such as cleaning arteries) within a living being.

nanotechnology: Technology pertaining to molecular-scale circuits, computers, ROBOTS, and engineered life forms.

nanovirus: A self-replicating form of NANOTECHNOLOGY designed for biological engineering.

neurovirus: A NANOVIRUS designed to affect the brain.

nootropics: Drugs designed to enhance intelligence.

outer system: The solar system beyond the orbit of Mars out to the Oort Cloud.

pantropy: The reshaping of life forms to adapt them to other environments.

parahuman: A TRANSGENIC human.

pharm: Pharmaceutical; often applied to TRANSGENIC plants or animals GENGINEERED to manufacture drugs or other products within their bodies.

posthuman: An entity that has evolved beyond its humanity.

puppeteer: An INFOMORPH that takes control of a biological entity.

rad: A unit of radiation.

robot: A CYBERSHELL occupied by an AI.

sapient: Capable of reasoned thought, like a human.

sapient uplift: A nonsapient animal upgraded with BIOMODS or GENEMODS that make it SAPIENT.

shadow: An imperfect, nondestructive MIND EMULATION.

slink: Sensory link implant.

slowhauler: A DEEP SPACE transport designed for slow interplanetary journeys. Most slowhaulers are unmanned.

specific impulse: A measure of the performance of rocket engines; the number of seconds an engine operates on one pound of fuel while producing a thrust of one pound.

teletrooper: A soldier operating a remote-controlled military CYBERSHELL.

transgenic: Having genes from more than one species.

transhuman: A transitional state between human and POSTHUMAN.

uplift: The process of modifying a nonsapient animal to enhance its intelligence, communications abilities, or tool-using capabilities. Also used as a slang term for the resulting entity.

upslink: A brain implant that translates a person's analog sensory experience into digital information.

virtual interface: A wearable or implant computer designed to house an INFOMORPH and use AUGMENTED REALITY.

virtuality: Virtual reality.

v-tag: A label linked to the Web and viewable through augmented reality.

Web: The global data network, descended from the 20th-century Internet and named after the World Wide Web. Capitalized, it refers to Earth's Web.

weblife: An infomorph that spends most of its time on the Web, generally residing in an immobile computer body.

SLANG

See *Jargon* (above) for definitions of technical terms.

baomubot: A nanny robot or an infomorph programmed to look after a child.

belt: The Main Belt.

blackjacker: A privateer, claim jumper, or space pirate operating in the Main Belt, Trojans, or Kuiper Belt. Derived from an incident in 2097 (see p. 16).

Bollywood: The heart of the global entertainment industry, in India.

brainbug: Popular term for nanodrugs that affect the user's brain chemistry.

carbon rice bowl: Derogatory reference to nanosocialist economies.

cyberswarm: A swarm of microbots.

Deep Beyond: All of space from the asteroid belt outward from the sun.

elf: A native of L5, or a poor immigrant to the outer system. From "L5."

gunjing: A cop or security guard.

hir: Address used for individuals of uncertain, neutral, dual, or polymorphic sexuality, including transgendered individuals, genderless AIs, and hermaphromorphs.

kuang-shi: A Chinese zombie; slang for bioshells.

liumang: Outlawed nanotechnology. Derived from a Chinese word for "biting insect," which also carries the connotation of "outlaw."

mangliu: Martian slang for a migrant microgravity worker. Derived from a Chinese word for "floater" (in the sense of "itinerant").

meat puppet: Derogatory term for bioshells, especially those used as sex toys.

memetically challenged: Not with it.

mobot: Contraction of mobile robot.

nanosoc: A nanosocialist.

postal: Cutting edge – especially in regard to biological modification or genetic engineering. Derived from "posthuman."

rabbit: A native of Luna.

shoumu: Slang term for entering nanostasis. Derived from Chinese phrase for "wood of good fortune and long life," a euphemism for coffin.

slinky: A recording made of a slink experience.

Tennin: Japanese for "heaven people" or "angels." Used for individuals with calcium-hack species modifications in general, and *Tennin* parahumans in particular.

Well, the: The inner solar system from Mars to the sun.

xox: A mind emulation that is a copy of another mind emulation. Also used as slang for any form of copy. Pronounced "zox."

xoxing: Making multiple mind emulations of someone.

xoxworkers: A team of identical mind emulations working together.

yuhangyuan: Space navigator; Chinese term for space pilot.

zhongdian renkou: Chinese for "special population," a euphemism for bioroids.

ABBREVIATIONS

See *Jargon* for definitions of technical terms.

AI: Artificial Intelligence.

AKV: Autonomous Kill Vehicle; a robot space fighter.

ASIT: Adjusted Sapience Intelligence Test.

AU: Astronomical Unit; 93,000,000 miles or 500 light-seconds.

cDAM: 100 hit points of damage. Thus, cDAM 3d is actually 300d.

cDR: 100 points of DR. Thus, cDR 3 is actually DR 300.

cf: Cubic feet.

cPF: Radiation protection factor (PF) effective against c-rads.

CR: Control Rating (see p. B249).

c-rad: Cosmic rays or other super-penetrating radiation.

D: Deuterium.

DSOV: Deep Space Operations Vehicle.

ESA: European Space Agency.

ESV: Executive Space Vehicle; a space yacht.

E.U.: European Union.

G: Gravity; a unit of 1 Earth gravity (e.g., 0.5 G is half Earth's gravity).

GB: Gigabyte; a measure of data storage equal to 1,000 megabytes.

GEO: Geosynchronous Earth Orbit.

GMO: Genetically Modified Organism (usually crops).

He-3: Helium-3.

HEO: High Earth Orbit.

HSTV: Heavy Space Transport Vessel; a large space freighter.

Isp: Specific impulse.

kJ: Kilojoule.

ksf: 1,000 square feet. Thus, 3 ksf is 3,000 square feet (sf).

kW: Kilowatt.

L4: The Earth-Lunar Lagrange 4 point.

L5: The Earth-Lunar Lagrange 5 point.

LAI: Low-sapient Artificial Intelligence.

LC: Legality Class (see p. B249).

LEO: Low Earth Orbit.

M$: Million dollars.

mps: Miles per second. 1 mps = 3,600 mph.

MW: Megawatt.

NAI: Nonsapient Artificial Intelligence.

NEA: Near-Earth Asteroid. An asteroid whose orbit occasionally crosses Earth's orbit or which approaches within 1.3 AU of the sun.

OTV: Orbital Transfer Vehicle; a space bus or truck.

PF: Protection Factor (against radiation).

PLAN-SF: Peoples' Liberation Army Navy Space Force.

PRA: Pacific Rim Alliance (led by Australia, Japan, and Korea).

PSV: Passenger Space Vehicle; a liner.

RSV: Remote Survey Vehicle; a space probe.

SAI: Sapient Artificial Intelligence.

SCV: Space Control Vehicle; a deep space carrier.

SDV: Space Dominance Vehicle; a deep space cruiser.

TAV: Transatmospheric Vehicle; an aerospace plane.

TB: Terabyte; a measure of data storage equal to 1,000 GB.

TCAV: Transatmospheric Combat Air Vehicle; an aerospace fighter.

TEN: Telepresence Experience Network; a news network.

TSA: Transpacific Socialist Alliance (led by Indonesia and Peru).

UCAV: Uninhabited Combat Air Vehicle; a cybershell aircraft.

USAF: United States Aerospace Force.

USV: Utility Space Vehicle; a multipurpose space transport.

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Online Resources

The ***Transhuman Space*** web page at **www.sjgames.com/transhuman/** maintains updated links to online documents and web pages relating to both transhumanism and space colonization.

GURPS Lite FOR TRANSHUMAN SPACE

WHAT IS GURPS?

GURPS stands for "Generic Universal RolePlaying System," the RPG from which these rules are condensed. Why is it called that? Well . . .

"Generic." ***GURPS*** starts with simple rules, and builds up to as much *optional* detail as you like.

"Universal." The rules system is designed to be adaptable to any genre or setting.

"RolePlaying." This is not just a "hack-and-slash" game. The rules are written to make true roleplaying possible – and to encourage it. ***GURPS*** is a game in which you take on the persona of another character – and pretend, for a little while, to *be* that character.

"System." Over 150 different books have been published for ***GURPS,*** in eight different languages (so far). It is one of the recognized standards for roleplaying, worldwide.

GURPS Rules
Steve Jackson

GURPS Lite Abridged Rules
David Pulver and Sean Punch

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About GURPS Lite

This is the boiled-down "essence" of ***GURPS:*** all the fundamental rules, but not the options and embellishments that often confuse new players. Once you're comfortable with these rules, you can pick up the ***GURPS Basic Set*** and jump right into the action.

Materials Needed for Play

To play, you will need these rules, three six-sided dice, pencils, and scratch paper.

BASICS

GURPS uses six-sided dice. To figure combat damage, the "dice+adds" system is also used. If a weapon does "7d+1" damage, this means "roll seven dice and add 1 to the total." Likewise, "3d-1" means "roll three dice and subtract 1 from the total." If you see just "6d," that means "roll six dice." For big numbers, dice can be multiplied; e.g., "6d×2" means "roll six dice and multiply by 2."

GURPS Lite has only three basic "game mechanics": *success* rolls, *reaction* rolls, and *damage* rolls.

Glossary

Like any hobby, gaming has a jargon. To help you understand the concepts and terms used in ***GURPS*** and other *roleplaying games,* we'll start with a few definitions:

roleplaying game (RPG): A game, like this one, in which a *Game Master* guides several players through an *adventure* in which they play the parts of imaginary individuals, or *characters*, in a fictional *game world.*

Game Master (GM): The referee, who creates the *adventure*, talks the players through it, and judges the results.

character: Any being played by the GM or a player in a RPG.

nonplayer character (NPC): Any character played by the GM. The GM may control many characters, major and minor.

player character (PC): Any character played by one of the players. Typically, each player controls one character.

statistics (stats): Numbers rating a character's abilities, used to determine what each one can and cannot do. See p. 210.

party: A group of PCs taking part in an *adventure*.

game world: A background for play and setting for an *adventure* – for example, the solar system in 2100.

adventure: The basic "unit" of play in a RPG, sometimes called a *scenario.* A RPG is never over until the players want to end it, but a single adventure has a beginning and an end. It may last through several sessions of play, or be done in a single evening.

encounter: One "scene" of an adventure; a meeting between the PCs and one or more NPCs.

campaign: An ongoing series of adventures, usually with a continuing cast of PCs, and the same GM.

SUCCESS ROLLS

A "success roll" is a die roll made when you need to "test" one of your skills or abilities. Sometimes you roll; sometimes the GM rolls for you. For instance, you might test, or *roll against,* your Strength (ST) to stop a heavy door from closing.

Roll 3 dice and add them together for a success roll. If your roll is *less than* or *equal to* the skill or ability you are testing, you succeeded. Otherwise, you failed. For example, if you roll against Strength, and your ST is 12, a roll of 12 or less succeeds. Thus, the higher the stat you are rolling against, the easier it is to succeed.

WHEN THE GM ROLLS

Normally, the player rolls dice for his own character. There are two exceptions:

1. A situation in which the *character* shouldn't be able to tell whether he has succeeded – especially when trying to get information. The GM rolls in secret. If the roll succeeds, the GM gives the player true information. If the roll fails, the GM lies or gives no information.

2. A situation in which the *player* shouldn't know what's going on. This includes most Sense rolls (see pp. 230-231). The GM rolls in secret, and then tells the player what his character has learned (if anything).

MODIFIERS AND EFFECTIVE SKILL

The GM may assign *modifiers* (*bonuses* or *penalties)* to a roll. For instance, if you tried to stop a *very heavy* door from closing, you might roll against Strength at a penalty of -2 (or ST-2, for short) because it's so heavy. In that case, with ST 12, you'd need to roll a 10 or less to succeed. Likewise, for an especially easy task, you would get a bonus to your attempt. You might roll "Diagnosis+3" to identify a common illness. If your skill were 12, a 15 or less would succeed.

Your *effective skill* for a given task is your *basic skill* (your actual level in that skill) plus or minus any appropriate modifiers. In the example above, your basic skill is 12 but your effective skill is 15. You may not attempt to roll if your *effective* skill is less than 3, unless attempting a defense roll (see p. 233).

CRITICAL SUCCESS AND FAILURE

A *critical success* is an especially good result on a skill roll; a *critical hit* is a critical success scored on an attack (see p. 232). You score a critical success as follows:

- A roll of 3 or 4 is always a critical success.
- A roll of 5 is a critical success if your effective skill is 15+.
- A roll of 6 is a critical success if your effective skill is 16+.

The GM determines what happens when you roll a critical success. This is always something good; the better the roll, the better the "bonus" he gives you.

A *critical failure* is an especially bad result on a skill roll. You score a critical failure as follows:

- A roll of 18 is always a critical failure.
- A roll of 17 is an ordinary failure if your effective skill is 16 or better, and a critical failure if your effective skill is under 16.
- Any roll of 10 greater than your effective skill is a critical failure. That is, 16 on a skill of 6, 15 on a skill of 5, and so on.

The GM determines what happens when you roll a critical failure. It's always something bad; the worse the roll, the worse the result.

AUTOMATIC SUCCESS

Some things are totally trivial. No roll is required when common sense says that both failure and critical success are impossible. However, if there is any chance of failure, a roll is required. Finding your corner store requires no roll. Hitting a target at point-blank range, even for an experienced soldier, does – a gun can misfire due to bad ammunition or bad luck.

REPEATED ATTEMPTS ON SUCCESS ROLLS

Sometimes, you have only one chance to do something; other times, you can try over and over until you succeed. Occasionally, you will not know whether you succeeded or failed until it's too late to try again. Finally, there will be times when you are injured by failure but can afford to fail a few times. The GM can use common sense to distinguish among these, according to the situation in which the characters find themselves, but as a rule:

- If the first failure kills them (or destroys the object of the attempt), that's that.
- If a failure causes damage of some kind, assess the damage and let them try again after a "reasonable" time passes.
- If a failure causes no damage, let them try again after a reasonable time, at a -1 penalty for each attempt after the first.

CONTESTS OF SKILL

A *Contest of Skill* is a quick way to resolve a competition between two characters without playing it out in detail. Both characters make their success rolls in the appropriate skill. Any appropriate modifiers are used.

There are two types of Contest:

A *Quick Contest* is usually over in a second; e.g., two people grabbing for the same weapon. Each character makes his skill roll. If one succeeds and the other fails, the winner is obvious. If both succeed (or fail), the winner is the one who succeeded by the most, or failed by the least. A tie means nobody won.

A *Regular Contest* may take some time; e.g., a legal battle. Each character tries his skill roll. If one succeeds and the other fails, the winner is obvious. If both succeed or both fail, the characters' relative positions are unchanged, time passes, and they may try again. The time each attempt takes will depend on the activity, and is determined by the GM. In a combat situation, each attempt takes one second. In a library-research scenario, with the fate of the world hanging on who finds a certain obscure reference first, each attempt could represent days.

If both characters have very high skill, the Contest could go on indefinitely; therefore, shorten it as follows: if both skills are over 14, reduce the higher one to 14, and subtract the same amount from the lower one.

Eventually, one character will make his roll and the other one will miss. The one who made his roll wins the Contest.

REACTION ROLLS

A "reaction roll" is a roll made by the GM to determine how his NPCs react to the PCs. This roll is always optional, and the GM may predetermine reactions instead; however, it can be fun to let the dice decide. If the GM decides a rolled reaction is inappropriate, he should feel free to modify it.

To check reactions, the GM rolls 3 dice and consults the *Reaction Table* (below). The higher his roll, the better the NPCs will react, and the better they will treat the PCs.

Reaction rolls are typically made in potential combat situations, during commercial transactions, in response to requests for aid or information, and to determine the attitude and loyalty of NPC hirelings.

REACTION MODIFIERS

A *reaction bonus* is a factor that makes the NPCs more friendly; a *reaction penalty* is something that makes them less friendly. Types of reaction modifiers include:

Personal modifiers. For appearance, social standing, etc.

Situational modifiers. Offering someone a bad business deal, or trying to convince a foe not to attack when you're badly outnumbered, might give you a penalty. Offering a good deal, or dealing with an old and trusted employee, could give a bonus. This is up to the GM.

Appropriate behavior by the PCs should always affect reaction rolls. A good approach should be worth a +1 modifier or more; an inappropriate approach might give a -1 or -2.

REACTION TABLE

Roll 3 dice and apply any reaction modifiers.

0 or less: Disastrous. The NPC *hates* the characters and will act in their worst interest. Nothing is out of the question: assault, betrayal, public ridicule, and ignoring a life-or-death plea are all possible.

1 to 3: Very Bad. The NPC dislikes the characters and will act against them if it's convenient to do so: attacking, offering grossly unfair terms in a transaction, and so on.

4 to 6: Bad. The NPC cares nothing for the characters and will act against them, if that serves his own interests.

7 to 9: Poor. The NPC is unimpressed. He may threaten, demand a huge bribe for his aid, or something similar.

10 to 12: Neutral. The NPC has no feelings for the characters, and ignores them if they do the same. Transactions will go smoothly and routinely, as long as protocol is observed.

13 to 15: Good. The NPC likes the characters and will be helpful within normal, everyday limits. Reasonable requests will be granted.

16 to 18: Very Good. The NPC thinks highly of the characters and will be quite helpful and friendly, freely offering aid and favorable terms in most things.

19 or better: Excellent. The NPC is extremely impressed by the characters, and will act in their best interests at all times, within the limits of his own ability – perhaps even risking his life, wealth, or reputation.

DAMAGE ROLLS

A "damage roll" is a roll made to determine how much injury a successful attack or a mishap inflicts. Many things can affect the final damage inflicted: armor protects the wearer, certain weapons do extra damage if they penetrate armor, and some "critical hits" bypass the damage roll altogether. All of these things are explained under *Combat* (see pp. 231-236).

CHARACTERS

Creating a character is the first part of the game. The idea of roleplaying is to take the part of another person – a "character" you create. The way to create a character is to *design* him, just as though he were a character in a story you were writing. Start by deciding what type of person you want to be. You can take inspiration from a fictional hero or heroine – or create your new "self" from the ground up. The GM may require your character to fit a particular campaign concept (e.g., "you're all cops in 2100-era New York").

Character Story: This is the pre-game history of a character, written by the person who plays that character. This is a great aid to roleplaying. It is optional, but recommended. You might even want to write the story first, and *then* work out your character's stats. If you write a character story, show it to the GM, but not necessarily to the other players. After all, your character probably has some secrets!

CHARACTER POINTS

When you create a character, the GM gives you a certain number of *character points* to "spend" on your character's abilities. See *Character Points* (p. 110) for recommended point totals. These rules assume competent or heroic characters; most ordinary people have only 25-75 points.

The following sections describe things you can spend your character points on. Helpful traits (e.g., great strength, wealth, above-average appearance, and skills) *cost* points in proportion to their value. Traits that limit your options (e.g., honesty, weakness, poverty, and fear of heights) *give* you extra points that can be used to buy additional helpful traits.

ATTRIBUTES

Four numbers called "attributes" are used to define your basic abilities:

Strength (ST), a measure of "brawn" or physical muscle.

Dexterity (DX), a measure of agility and coordination.

Intelligence (IQ), measuring brainpower, alertness, and adaptability.

Health (HT), a measure of energy and vitality. HT also stands for "hits" or "hit points" – the amount of physical damage a character can take. When you have taken "hits" equal to your Health score, you soon fall unconscious. Further injury can kill.

For each attribute, a score of 10 represents human average; anything from 8 to 12 is in the range considered "normal" for humans. An attribute of 1 is the lowest score permitted. There is *no* upper limit, but for humans, above 16 is very unusual; above 20 is superhuman!

The four attributes are considered equally valuable. The point cost for beginning attributes is given in the table to the left. A score of 10 in any attribute is *free.* Scores below 10 have a negative cost – they "give you back" some points!

ATTRIBUTES

Level	Point Cost
1	-80
2	-70
3	-60
4	-50
5	-40
6	-30
7	-20
8	-15
9	-10
10	0
11	10
12	20
13	30
14	45
15	60
16	80
17	100
18	125
+1	+25

IMAGE AND LOOKS

This section addresses your character's *intrinsic* "social" traits: appearance, manner, and bearing. Traits with positive point values (e.g., above-average Appearance, Voice) are considered *advantages* (p. 215). Those with negative values (e.g., below-average appearance, Odious Personal Habits) are treated as *disadvantages* (p. 217), and obey all the usual rules for disadvantages. Still others (e.g., height and weight, handedness) are *features* that merely add "color."

Appearance — *Variable*

You are free to set the physical appearance of your character in any way you like. However, outstanding good (or bad) looks are an advantage (or disadvantage). Good looks cost points; bad looks give you bonus points to spend elsewhere. Reaction-roll modifiers due to Appearance apply only to people who can see you.

Hideous Appearance: Any sort of disgusting looks you specify: hunchback, severe skin disease, wall-eye . . . preferably several at once. -4 on reaction rolls. *-20 points.*

Ugly Appearance: As above, but not so bad – maybe only stringy hair and snaggle teeth. -2 on reaction rolls. *-10 points.*

Unattractive Appearance: You just look vaguely unappealing. -1 on reaction rolls. *-5 points.*

Average Appearance: No bonuses or penalties; you blend easily into a crowd. No point cost or bonus.

Attractive Appearance: You may not enter beauty contests, but you're good-looking. +1 on reaction rolls. *5 points.*

Handsome (or Beautiful) Appearance: You *could* enter beauty contests! +2 on reaction rolls made by the same sex; +4 on reaction rolls made by the opposite sex. *15 points.*

Very Handsome (or Beautiful) Appearance: You *win* beauty contests. +2 on reaction rolls made by the same sex; +6 (!) on reaction rolls by opposite sex. *25 points.*

Charisma — *5 points/level*

This is the natural ability to impress and lead others. It affects all reaction rolls made by sapient beings. *5 points per +1 reaction bonus.*

Handedness — *No point cost*

Decide whether you are right- or left-handed. These rules assume you are right-handed unless you decide otherwise or buy Ambidexterity. If you try to do anything significant – fire a pistol, forge a letter, etc. – with your "off" hand, you will be at a -4 penalty. This does not apply to things you *normally* do with your off hand.

Ambidexterity — *10 points*

You can use both hands with equal skill, ignoring the -4 penalty for "off hand" use.

Height and Weight — *No point cost*

Players are free to select height and weight for their characters, within reason. Someone of ST 10 is usually about 5'10" and 150 lbs. Add 1" of height and 5 lbs. of weight per point of ST above 10 (add 10 lbs. of weight per point of ST above 14); subtract the same per point of ST below 10. These values assume a man. For a woman, subtract 2" from average height and 10 lbs. from average weight. As much as 6" variation in height and 40 lbs. variation in weight is believable, but those of above-average Appearance should have a weight within 20% of "average" for their height.

Overweight — *-5 points*

You are unusually heavy. Determine weight normally for ST, and then increase it by 30%. This extra weight counts as encumbrance (p. 228) that you cannot get rid of. (*Exception:* when swimming, ignore this extra weight and add +2 to Swimming skill.) Being overweight carries a reaction penalty of -1 among health-conscious societies and in areas where food is in short supply.

GURPS®
CHARACTER SHEET

Name
Player
Appearance

Date Created

Sequence

Unspent Points

Point Total

Point Cost

ST

DX

IQ

HT

FATIGUE

DAMAGE
Thrust:
Swing:
Kick:
:

HITS TAKEN

MOVE	BASIC SPEED (HT+DX)/4	MOVE Round Off
SWIM		

ENCUMBRANCE — MOVE
None (0) = 2×ST
Light (1) = 4×ST
Med (2) = 6×ST
Hvy (3) = 12×ST
X-hvy (4) = 20×ST

ACTIVE DEFENSES

DODGE	PARRY	BLOCK
= Move	Weapon/2	Shield/2

BODY PROTECTION

	Head	Body	Arms	Legs	Hands	Feet	ALL
PD							
DR							

OTHER PD
Shield:

OTHER DR

ADVANTAGES, DISADVANTAGES, and QUIRKS

	Point Cost		Point Cost

SKILLS	Point Cost	Level

SUMMARY — Point Total
Attributes
Advantages
Disadvantages
Quirks
Skills
TOTAL

Skinny *-5 points*

You are notably underweight. Figure weight and height normally, and then cut your weight by 1/3. You may not take Handsome or Very Handsome appearance, and your HT may not exceed 14. Clothes and body armor tailored for average-sized people will not fit you, and you will be at -2 to Disguise skill, or to Shadowing skill to follow someone in a crowd (unless they're *all* Skinny!).

Odious Personal Habits *-5/-10/-15 points*

You behave, some or all of the time, in a fashion repugnant to others. The worse your behavior, the more bonus points you receive. Specify the behavior when the character is first created, and work out the bonus with the GM. Body odor might be worth -5 points, spitting on the floor would be worth -10 points; -15-point habits are left to the imagination of those depraved enough to want them. For each -5 points your habit is worth, subtract 1 from all reaction rolls made by someone in a position to notice.

Voice *10 points*

You have an attractive voice. You get +2 to Bard (or Public Speaking) skill, and on these Influence Skills (p. 222): Diplomacy, Savoir-Faire, and Sex Appeal. You also get +2 on any reaction roll made by someone who can hear your voice.

SOCIAL STANDING

This section contains rules for defining your character's place in society. As for *Image and Looks,* above, traits with positive point values are advantages, while those with negative values are disadvantages.

Clerical Investment *5 points/level of rank*

This is the social/political advantage of being invested as a cleric of your religion. Its level represents your influence within that church. You have a number of powers and privileges that a layman lacks, including a +1 reaction bonus *per level of rank* from followers of your religion and those who respect your faith. Most ordinary clerics have one level.

Duty *Variable*

You belong to an intelligence agency, a military or police force, an emergency-rescue team, or similar organization that can order you to undertake unpleasant or hazardous activities whether you like it or not. The GM rolls once at the beginning of each adventure to see if the character (or a group of characters, if they all have the same Duty) will be "called to duty" in that adventure. The point cost of a Duty depends on the frequency with which it is demanded (all rolls are on three dice):

Almost all the time (roll of 15 or less): *-15 points.*
Quite often (roll of 12 or less): *-10 points.*
Fairly often (roll of 9 or less): *-5 points.*
Occasionally (roll of 6 or less): *-2 points.*

An ordinary job is not a Duty. If a Duty does not require you to risk your life, at least occasionally, reduce its value by 5 points, which negates Duties less frequent than "quite often."

On the other hand, an *Extremely Hazardous Duty,* where you are "on duty" all the time and risk death or serious injury, is worth -20 points. This is typical of front-line fighters in war zones.

An *Involuntary Duty*, enforced by threats to you or your loved ones, or by mind control, is worth an extra -5 points; it can also be Extremely Hazardous.

Legal Enforcement Powers *5/10/15 points*

You are an officer of the law, with all the accompanying powers and restrictions. The rights and privileges of your branch of law enforcement determine the cost. A cop with local jurisdiction, the ability to arrest suspected criminals, the power to perform searches with an appropriate warrant, and *possibly* the right to carry a concealed weapon, has 5-point Legal Enforcement Powers. A law enforcer with national or international jurisdiction, *or* not obligated to respect the civil rights of others, *or* free to engage in covert investigations, *or* able to kill with relative impunity, has 10-point Legal Enforcement Powers. Someone with three or more of the above abilities has 15-point Legal Enforcement Powers.

Military Rank *5 points/level of Rank*

You have rank in a military organization. Each level of Rank gives authority over those of lower Rank. Typically, enlisted personnel are Rank 0, NCOs (like sergeants) are Rank 1-2, and officers are Rank 3+. Generals or the equivalent are Rank 7 or 8 (the maximum level of Rank).

Military Rank gives a Status bonus, which need *not* be paid for separately; see *Status* (p. 213) for more information.

Military Rank almost always involves a significant Duty (see above).

Reputation *Variable*

Some people are so well known that their reputation actually becomes an advantage or a disadvantage. The details of your reputation are up to you; you can be known for achievement, bravery, or whatever you want. If you have a reputation, your name or your face will be enough to trigger a "reputation roll" to see if the people you meet have heard of you. Roll once for each person or small group you meet. For a large group, the GM may roll more than once if he likes.

There are three components to your reputation: *Type of Reputation, People Affected,* and *Frequency of Recognition.*

Type of Reputation affects the reaction modifier that you get from people who recognize you. For every +1 bonus to a reaction roll (up to +4), the cost is 5 points. For every -1 penalty (down to -4), the cost is -5 points.

People Affected modifies the value of your reputation. The larger the "affected class" (people who might have heard of you), the more your reputation is worth, as follows:

Everyone you will meet in your campaign: use listed value.

Large class of people (e.g., teen-age girls): 1/2 value (round down).

Small class of people (e.g., genetic engineers): 1/3 value (round down).

If the class of people affected is so small that, in the GM's opinion, you would not meet even one in the average adventure, your reputation doesn't count at all.

Frequency of Recognition also modifies a reputation's value. The more often you are recognized by members of the "affected class," the more important that reputation is (all rolls are on three dice):

All the time: no modifier.

Sometimes (roll of 10 or less): 1/2 value, rounded down.

Occasionally (roll of 7 or less): 1/3 value, rounded down.

Social Stigma -5/-10/-15 points

You are of an ethnicity, race, or sex that your culture considers inferior. The "stigma" must be obvious to anyone who sees you; otherwise, it's a Reputation. The point bonus depends on the reaction penalty:

Second-class citizen (e.g., a bioroid in many societies): -1 on all reaction rolls except from others of your own kind. *-5 points.*

Valuable property (e.g., a cybershell): This usually takes the form of limited freedom or lack of intellectual respect. *-10 points.*

Minority group (e.g., an exotic parahuman in a region where they're rare): -2 on all reaction rolls made by anyone except your own kind, but +2 on rolls made by your own kind. *-10 points.*

Outsider, outlaw, or barbarian (e.g., an obvious combat cybershell outside of an army base or war zone): You get -3 on all reaction rolls, but +3 from your own kind when met outside your home culture. *-15 points.*

Anyone who takes a Social Stigma must be bound by it . . . roleplay the difficulties it causes!

Status 5 points/level of Status

Status is an indication of your *class* in society. Anyone can determine your Status by looking at you, your dress, and your bearing. If you have very high Status, your *face* may be easily recognized – or perhaps your entourage will get the message across.

Status is measured in "social levels," ranging from -4 (nonperson) to 7 (head of state); the definition of each level is given on the *Status Table* (p. 128). The point cost is 5 points per level of Status; e.g., Status 5 costs 25 points, while Status -3 is a *disadvantage* worth -15 points.

High Status: You are a member of a privileged class. Others in your culture (only) defer to you. Because of the common relationship between Status and Wealth (see below), a wealth level of Wealthy or above lets you pay 5 fewer points for high Status: you get one level of Status free. Likewise, Military Rank gives a free +1 Status per three *full* levels of Rank.

Low Status: You are a homeless individual, a nonperson, etc. Note that this is not the same thing as a Social Stigma.

Status as a Reaction Modifier: When a reaction roll is made, the *difference* in Status between the characters involved can affect the reaction. *Higher Status usually gives you a bonus.* If you have Status 3, for instance, those of Status 1 would react to you at +2. *Negative Status usually gives a penalty.* If your Status is negative, those of higher Status will react badly to you. Take the difference between your Status and the NPC's as a reaction penalty, but no worse than -4. *Lower Status may give a penalty.* If you are dealing with an NPC who is basically friendly, your Status won't matter (as long as it's positive). But if the NPC is neutral or already angry, lower Status makes it worse.

WEALTH

Wealth governs:

- How much money you start play with.
- How much money you earn per game month (though this depends on your specific job, too).
- How much time you must spend earning your living.

All characters get the "standard" starting wealth unless they paid extra character points for high wealth (the Wealth advantage) or took the disadvantage of low wealth (the Poverty disadvantage); "wealth levels" are explained below.

GURPS uses a $ sign to indicate money, regardless of the specific currency. Standard starting wealth is $30,000. For more on how wealth works, see *Wealth* (pp. 127-128) and *Available Wealth* (p. 137).

Wealth Levels Variable

Dead Broke: You have no job, no source of income, no money, and no property other than the clothes on your back. *-25 points.*

Poor: You have 1/5 the standard starting wealth. You spend 25 hours per week at your job. Some jobs are not available to you, and no job you find will pay you very well. *-15 points.*

Struggling: Your have 1/2 the standard starting wealth. You spend 20 hours per week at your job. Most jobs are open to you, but you don't earn much. *-10 points.*

Average: You have standard starting wealth. You spend 20 hours per week at your job, and support an average lifestyle. No point cost or bonus.

Comfortable: You have twice the standard starting wealth. You spend 20 hours per week at your job. You work for a living, but your lifestyle is better than average. *10 points.*

Wealthy: You have 5 times the standard starting wealth. Your job takes only 10 hours per week. You live very well! This level of wealth, and higher, may not be chosen without the GM's permission! *20 points.*

Very Wealthy: You have 20 times the standard starting wealth. You spend only 5 hours a week looking after business. *30 points.*

Filthy Rich: You have 100 times the standard starting wealth. You spend 5 hours a week on business. *50 points.*

Multimillionaire: If you have the Filthy Rich advantage, you may buy additional levels of wealth. Each increases your wealth by a factor of 10 (e.g., the first level would increase total wealth to 1,000 times standard starting wealth) and also grants a free level of Status, to a maximum bonus of +2 over the free level given for high Wealth. *25 points per level.*

The workweeks given above have been adjusted to agree with *Working Hours* (p. 137); double the length of all work weeks in earlier eras.

FRIENDS AND FOES

Many characters have NPCs who are especially well- or ill-disposed toward them. Powerful friends you can call upon in times of need are an *advantage;* weaker friends you must defend are a *disadvantage,* as are powerful enemies.

Frequency of Appearance: When a character has friends or enemies like this, the GM rolls dice once per adventure to see if they will get involved. The chance on three dice of a powerful friend showing up or otherwise aiding you, or of a weaker friend or an enemy somehow complicating your life, is called his *frequency of appearance.* This adjusts the NPC's value as an advantage or disadvantage, after all other factors have been considered, as follows:

Appears almost all the time (roll of 15 or less): triple cost.
Appears quite often (roll of 12 or less): double cost.
Appears fairly often (roll of 9 or less): listed cost.
Appears rarely (roll of 6 or less): half cost (round up).

Dependents *Variable*

An NPC for whom you are responsible is a *Dependent,* and is considered a disadvantage. This may be your child, sidekick, spouse, or anyone else you feel an obligation to look after. If your Dependent is kidnapped during play, you must go to the rescue as soon as you can. If your Dependent is in trouble and you don't go to his aid immediately, the GM can deny you bonus character points (see p. 228) for "acting out of character." You never get any character points for a play session in which your Dependent is killed or badly hurt.

The Dependent is created just like any other character, but instead of the 100 points used to create a PC, you use 50 points or less. A Dependent built with 0 or fewer points is worth -16 points, one who is built with 1 to 25 points is worth -12 points, and one built with 26 to 50 points is worth -6 points. A Dependent built with 50+ points is not worth any bonus points.

The more important the Dependent is to you, the more points he is worth. For an employer, acquaintance, or other person to whom you may weigh risks in a rational fashion, *halve* the values above. For a friend you must *always* protect, unless something even more important is on the line, use the values above. For a loved one whose safety comes first, no matter what, *double* the values above.

Finally, pick a frequency of appearance (see above) that fits the "story" behind the Dependent.

No character may ever earn points for more than two Dependents at once.

Allies *Variable*

Allies are loyal comrades, faithful sidekicks, or lifelong friends, competent enough to accompany you on adventures. An Ally is an advantage. Allies are usually agreeable to the suggestions of their PCs, but they are not puppets. A PC should receive no character points for any play session in which he betrays, attacks, or unnecessarily endangers his Ally.

An Ally character is created just as though he were a PC. An Ally built on 51-75 points is worth no points, but must be protected like a Dependent. An Ally built on 76-100 points costs 5 points, one built on 101-150 points costs 10 points, and each additional 50 points the Ally has costs the PC an extra 5 points. However, an Ally built on over 50 points more than his PC is actually a *Patron* (see below).

An Ally with special abilities – for instance, political power out of proportion to his point value – may cost an extra 5 to 10 points, at the GM's discretion.

As for a Dependent, pick a frequency of appearance that fits the "story" behind the Ally.

Note that NPC Allies must all pay the points to have their PC as an Ally.

Patrons *Variable*

Powerful NPC friends are known as *Patrons.* Like Allies, Patrons are NPCs, created initially by the player but controlled by the GM. A Patron may be an advisor, protector, or a more-than-usually helpful employer. Unlike an Ally, a Patron does not adventure with a PC. Instead, the Patron offers advice, knowledge, equipment, influence, etc.

A Patron's value depends on his (or its) power. A single powerful individual (usually created with at least 50 points more than the PC), or a group with assets of at least 1,000 times standard starting wealth, is worth 10 points. An extremely powerful individual (created with at least 100 points more than the PC), or a reasonably powerful organization (assets equivalent to at least 10,000 times standard starting wealth), is worth 15 points. A very powerful organization (assets of at least a million times standard starting wealth) is worth 25 points. A national government or giant multi-national organization (net worth basically incalculable) is worth 30 points.

If a Patron supplies useful equipment, this adds 5 points to the cost. If the equipment is worth more than the standard starting wealth of the campaign, it adds 10 points.

Finally, pick an appropriate frequency of appearance.

Enemies *Variable*

An NPC or organization that is working against you, or just trying to kill you, is an *Enemy.* You are responsible for determining the nature of your Enemy when you first create your character, and must explain to the GM why this Enemy is after you. The GM always has the right to veto your choice of Enemy if it seems silly or too hard to fit into the campaign. To be worth points as an Enemy, your nemesis must be personal, not simply a common foe of everyone around you.

The point value of an Enemy is governed by his (or its) strength: the more powerful the Enemy, the more points he (or it) is worth as a disadvantage. A single above-average individual (created with about half as many points as the PC) is worth -5 points. One very formidable individual (created with about as many points as the PC), or a group of 3 to 5 "average" 25-50 point people, is worth -10 points. A medium-sized group (6 to 20 people) is worth -20 points. A large group (20 to 1,000 people), or a medium-sized group that includes some formidable or superhuman individuals, is worth -30 points. An entire government or other utterly formidable group is worth -40 points.

Once you know the base point value of the Enemy, pick an appropriate frequency of appearance.

Too many Enemies can disrupt a game; therefore, no character may take more than two Enemies, or more than -60 points of Enemies.

ADVANTAGES

Advantages are innate abilities. In general, a character may only be given advantages when he is first created. After that, the only way to gain them is through technology, such as biomod transplants (p. 161) or nanosymbionts (p. 165). Each advantage has a cost in character points. For some advantages, this is fixed. Others are bought in levels, at a certain point cost for each level. A character may have as many advantages as he can afford.

Absolute Direction/3D Spatial Sense 5/10 points

Absolute Direction: You have an excellent sense of direction. You always know which way is north, and you can always re-trace a path you have followed within the past month. Gives +3 to Navigation skill. *5 points.*

3D Spatial Sense: You think well in three dimensions. You enjoy all the benefits of Absolute Direction, +2 to Astrogation and Free Fall skills, and +1 to Piloting skill. *10 points.*

Absolute Timing 5 points

You have an accurate mental clock. You always know what time it is, down to the second. You can measure elapsed time with equal accuracy. You can wake up at a predetermined time if you choose.

Acceleration Tolerance 10 points

You can withstand high-G accelerations; add +5 to HT when rolling to avoid their effects.

Acute Sense(s) 2 points/level

You have above-average senses that give you a +1 bonus per level to IQ rolls made (by you, or by the GM on your behalf) to sense something. *Acute Hearing* gives a bonus to hear something. *Acute Taste/Smell* gives a bonus to notice a taste or smell. *Acute Vision* gives a bonus to see something. Each is a separate advantage.

Alertness 5 points/level

A general bonus to *any* Sense roll (pp. 230-231), or when the GM rolls against your IQ to see if you notice something. This is cumulative with Acute Senses. Each level gives a +1 bonus.

Combat Reflexes 15 points

You have extraordinary reactions and are rarely surprised. You get a +1 to any Active Defense in combat (see p. 233). You never "freeze up" in a surprise situation, and get +6 on any IQ roll to wake up or to recover from surprise or a mental "stun" (see p. 236).

Common Sense 10 points

Any time you start to do something that the GM feels is STUPID, he rolls against your IQ. A successful roll means he must warn you, "Hadn't you better think about that?" This advantage allows an impulsive *player* to take the part of a thoughtful character.

Composed/Unfazeable 5/15 points

Composed: You're very hard to panic: +2 on Will rolls to resist fear, except Phobias. *5 points.*

Unfazeable: Nothing surprises, frightens, or intimidates you. You always succeed on Will rolls to resist fear. You can't take Phobias. 15 points.

Deep Sleeper 5 points

You can quickly fall asleep in all but the worst conditions, and sleep through unthreatening disturbances. You always awaken feeling alert and rested.

Disease-Resistant/Immunity to Disease 5/10 points

Your body naturally resists disease organisms. This protects you against bacterial, viral, and fungal infections, but not parasites (e.g., tapeworms).

Disease-Resistant: You get +8 to HT to avoid catching any disease. *5 points.*

Immunity to Disease: You *never* catch any infection or disease, even if you are forcibly injected with it! You must start with a HT of 12 or better to take Immunity to Disease, but the advantage will remain if your HT is later reduced below 12. *10 points.*

Double-Jointed 5 points

Your body is unusually flexible. Gives +3 on any Climbing or Escape roll, or on any Mechanic roll (to reach into an engine, etc.).

Eidetic Memory 9/18 points

You remember everything you see or hear.

Level 1: You remember the general sense of everything. If exact recall is important, the GM rolls vs. your IQ (or IQ+4, if a normal person could recall it on an IQ roll). *9 points.*

Level 2: You have photographic recall; no need to roll. *18 points.*

These costs and descriptions *include* the limitation on p. 129.

Fit/Very Fit *5/15 points*

You are in peak condition for someone of your HT.

Fit: You lose fatigue points (see pp. 237-238) to exertion, heat, etc. at the normal rate, but recover them at twice the normal rate. Gives +1 on all HT rolls. *5 points.*

Very Fit: You lose fatigue points at *half* the normal rate, and regain them at twice the normal rate. Gives +2 on all HT rolls. *15 points.*

G-Experience *10 points*

You suffer only half DX penalty for gravity other than your home gravity.

Hard to Kill *5 points/level*

You are incredibly difficult to kill. Add +1 per level to HT rolls to avoid death when you are wounded to -HT or worse (see p. 236).

High Pain Threshold *10 points*

You are as susceptible to injury as anyone else, but you don't *feel* it as much. If you are hurt in combat, you are not stunned and do not have a "shock" penalty (p. 236) on your next turn. If you are tortured physically, you resist at +3.

Language Talent *2 points/level*

You pick up languages quickly. Whenever you learn any Language skill (see p. 224), add your level of Language Talent to your IQ.

Less Sleep *3 points/level*

You can stay awake and alert longer than most people. For you, a full night's sleep is 8 hours minus your level of this advantage, to a maximum of five levels (3 hours' sleep). A half-night's sleep is half this. See *Fatigue* (pp. 237-238).

Lightning Calculator *5 points*

You can do complex math in your head, instantly, as if you had a calculator.

Luck *15 points*

You were born lucky! Once per hour of play, you may re-roll a single bad die roll twice (this must be the last roll you made) and take the best of the three rolls! If the GM is rolling (e.g., to see if you notice something), you may tell him you are using your Luck, and he must roll three times and give you the best result. Your Luck only applies on rolls for your character to try to do something, OR on outside events that affect you or your whole party, OR when you are being attacked (in which case you may make the attacker roll three times and take the *worst* roll!). Luck cannot be shared.

Once you use your Luck, you must wait an hour of real time before using it again. Luck cannot be saved up. You cannot play for hours without using Luck and then use it several times in a row!

Manual Dexterity *3 points/level*

You get a +1 bonus per level to effective skill for non-combat tasks requiring fine motor skills, such as intricate mechanical repairs or surgery.

Mathematical Ability *10 points*

You get +3 on Mathematics and Computer skills (except Computer Operation), and +2 on Engineering skills.

Night Vision *10 points*

Your eyes adapt rapidly to darkness. You cannot see in *total* darkness – but if you have any light at all, you can see fairly well. Whenever the GM exacts a penalty because of darkness, except for total darkness, this penalty does not apply to you.

Rapid/Very Rapid Healing *5/15 points*

You recover rapidly from all kinds of wounds. These advantages are only available if your basic HT is 10 or above.

Rapid Healing: Whenever you roll to recover lost HT (p. 236), you get +5 to the roll. This does not help you get over stunning or similar incapacities. *5 points.*

Very Rapid Healing: As above, but when recovering lost HT, a successful HT roll heals *two* hit points, not one. *15 points.*

Resistant to Poison *5 points*

Poisons and drugs affect you less. You get +3 on HT rolls to their effects.

Sensitive/Empathy *5/15 points*

You have a "feeling" for people. When you first meet someone, or when you are reunited after an absence, you may ask the GM to roll against your IQ. He will then tell you what you "feel" about that person (a failed roll means he may *lie* to you). This talent is excellent for spotting imposters and determining the true loyalties of NPCs. You can also use it to determine whether someone is lying . . . not what the truth is, but whether they are being honest with you.

Sensitive: The IQ roll is made at -3. *5 points.*

Empathy: The IQ roll is made against unmodified IQ. *15 points.*

Single-Minded *5 points*

When you put your mind to something, you *concentrate*! You get a +3 bonus when working on lengthy tasks, but you may ignore other important tasks while obsessed (make a Will roll to avoid this). Roll at -5 to *notice* interruptions.

Strong Will *4 points/level*

You have much more "willpower" than the average person. Your level of Strong Will is added to your IQ when you make a Will roll (p. 231) for *any* reason.

DISADVANTAGES

These are problems acquired before the character first comes into play. As a rule, a character may only be given disadvantages when he is created.

Each disadvantage has a *negative* cost in character points – the worse the disadvantage, the higher this cost. Thus, disadvantages give you extra character points, which will let you improve your character in other ways. Besides, imperfections make your character more interesting and realistic, and add to the fun of roleplaying.

It is possible to "buy off" certain disadvantages and get rid of them in play by spending points equal to the value of the disadvantage; see p. 229.

"Good" Disadvantages: Within the framework of the game, several virtues, such as Honesty and Truthfulness, are treated as "disadvantages" because they limit your freedom of action.

Limiting Disadvantages: The GM should be careful how many disadvantages he allows players to take; too many disadvantages can turn your game into a circus. A suggested limit: disadvantages (other than those in racial/model templates) should not total more than -40 points. Negative social traits (bad Reputation; below-average Appearance, Status, and wealth; etc.), Dependents, Enemies, and points gained by reducing an attribute to less than 8 count against this limit. However, if only a single severe disadvantage is taken, it may have *any* cost.

Mental Problems: Many mental disadvantages let the afflicted character make IQ or Will rolls to avoid their bad effects. In these cases, any roll of 14 or over *still fails.*

Amnesia — *-10/-25 points*

You've lost your memory and can't remember your past life, including your name. Pick a level:

Partial: You design the character, but the GM may reserve up to 30 points for use as he sees fit. You may have enemies, friends, or skills of which you are unaware! *-10 points.*

Total: You only design those elements of your character (other than Amnesia) that you can see in a mirror; the GM designs the rest! The GM makes all your mental skill rolls in secret, at a -2 penalty. *-25 points.*

Bad Temper — *-10 points*

In any stressful situation, you must make a Will roll. A failed roll means you lose your temper, and must insult, attack, or otherwise act against the cause of the stress.

Bloodlust — *-10 points*

You want to see your foes *dead.* This only applies to actual enemies, not to friends with whom you argue, etc. You must make a Will roll to avoid a guard instead of attacking him, accept a foe's surrender, etc. If you fail, you attempt to kill your foe – even if it compromises other objectives.

Bully — *-10 points*

You like to push people around whenever you can get away with it. This may take the form of physical attacks, social harassment, etc. Make a Will roll to avoid gross bullying when you know you shouldn't – but to roleplay your character properly, you should bully anybody you can. Nobody likes a bully – others react to you at a -2.

Callous — *-6 points*

You are not necessarily *cruel,* but you care little about the pain of others. You ignore lost, crying children and push aside beggars. You get -2 on all rolls made for social interaction. This includes Diplomacy, Fast-Talk, Leadership, and Sex Appeal skills.

Chummy — *-5 points*

You work well with others and seek out company. When you are alone, you are unhappy and distracted, and suffer a -1 penalty to your mental skills. NPCs with this disadvantage react to the PCs at +2.

Compulsive Behavior — *-5 to -15 points*

You have a habit (usually a vice) you feel compelled to indulge on a daily basis, even though it wastes time or money, or gets you in trouble. Examples include gambling, attraction to another person, virtual-reality games, arguing, excessive curiosity, or even fighting. A Will roll is required to avoid the compulsion in a specific instance (or for a specific day) – but it is bad roleplaying to attempt to avoid the compulsion often!

The point value depends on what the behavior is, how much money it costs, and how much trouble it gets the PC into. The GM is the final judge.

Cowardice — *-10 points*

You are extremely careful about your physical well-being. Any time you are called on to risk physical danger, roll against Will (at -5 if you risk death). If you fail, you refuse to endanger yourself – unless threatened with *greater* danger! Soldiers, police, etc. react to a known coward at -2.

Fanaticism — *-15 points*

You believe so strongly in a country, organization, political philosophy, or meme that you put it ahead of *everything* else, even life! If the object of your fanaticism demands obedience to a certain code of behavior or loyalty to a leader, you give this unquestioningly. Roleplay your fanaticism.

Greed — *-15 points*

You lust for wealth. Any time riches are offered – as payment for fair work, gains from adventure, spoils of crime, or just bait – you must make a Will roll to avoid temptation. The GM may modify this roll if the amount of money involved is small or large relative to your own wealth. *Honest* characters (see p. 218) roll at +5 to resist a shady deal and +10 to resist outright crime.

Hidebound *-5 points*

You find it very hard to come up with an original thought. You get -2 on all rolls made for tasks that require invention or creativity (GM's decision).

Honesty *-10 points*

You *must* obey the law, and do your best to get others to do so as well. You are compulsive about it. This will often limit your options! Faced with unreasonable laws, roll against IQ to see the "need" to break them, and against Will to avoid turning yourself in afterward! You can lie if it does not involve breaking the law. Note that AIs with Reprogrammable Duty will not generally consider the restrictions on them to be "unreasonable."

Impulsiveness *-10 points*

You hate talk and debate. You prefer action! When alone, you act first and think later. In a group, when your friends want to stop and debate, put in your two cents' worth quickly – if at all – and then act! If it is absolutely necessary to wait and ponder, you must make a Will roll to do so.

Intolerance *-5/-10 points*

You dislike people who are different from you, reacting to them at -3. On a "good" or better reaction, you force yourself to tolerate them, coldly but civilly. On a "neutral" reaction, you tolerate their presence, but are openly disdainful. On a worse reaction, you will walk out, drive them off, attack them, etc. Members of the disliked group will sense your intolerance and reciprocate, reacting to you at -1 to -5.

Point value depends on the group affected. Intolerance of *anyone* not of your ethnic background is worth -10 points, as is intolerance of anyone who does not share your religion. Intolerance of one particular ethnic or religious group you routinely encounter is worth -5 points. Intolerance of a group you will rarely encounter is treated as a -1-point quirk (see p. 219). See p. 133.

Jealousy *-10 points*

You have a bad reaction toward anyone who seems smarter, more attractive, or better-off than you! You resist any plan proposed by a "rival," and *hate* it if someone else is in the limelight. If an NPC is Jealous, the GM will apply from -2 to -4 to his reaction rolls toward the target(s) of his jealousy.

Laziness *-10 points*

You are violently averse to physical labor. Your chances of getting a raise or promotion in *any* job are halved. If you are self-employed, your weekly income is halved. Avoid work – especially hard work – at all costs. Roleplay it!

Low Empathy *-15 points*

You have trouble understanding emotions. You may not take Empathy or Sensitive, and have a -3 penalty to use skills where understanding emotions would be important, especially Acting, Carousing, Criminology, Fast-Talk, Leadership, Merchant, Politics, Psychology, and Sex Appeal.

Miserliness *-10 points*

Like *Greed* (p. 217), except you are more concerned with holding on to what you already have. You may be both greedy *and* miserly! Make a Will roll when called on to spend money, and hunt for the best deal possible. If the expenditure is large, the Will roll may be at -5 (or worse). Failure means you refuse to spend the money – or, if it *must* be spent, haggle and complain!

Overconfidence *-10 points*

You think you are far more powerful, intelligent, and competent than you really are, and you act that way. Any time (in the GM's opinion) you show too much caution, roll against IQ. A failed roll means you can't be cautious . . . act as though you were able to handle the situation. An overconfident character gets +2 on reaction rolls from the young or naive, but -2 from experienced NPCs. This requires roleplaying. You may be proud and boastful, or just quietly determined.

Pacifism *-15 points*

You are opposed to violence. There are two different forms:

Self-Defense Only: You will only fight to defend yourself or those in your care, using minimum necessary force (no preemptive strikes!). Do your best to discourage others from violence, too. *-15 points.*

Cannot Kill: You may fight freely, but will never do anything that seems likely to kill another. This includes abandoning a wounded foe to die. Do your best to keep your companions from killing, too. If you kill (or feel responsible for a death), you suffer a nervous breakdown. Roll 3 dice: you're totally morose and useless (roleplay it!) for that many days, and during that time must make a Will roll to offer any violence toward *anyone*, for *any* reason. *-15 points.*

Phobias *Variable*

A "phobia" is a fear of a specific item or circumstance. Many fears are reasonable, but a phobia is an unreasonable, unreasoning, morbid fear. The more common an object or situation, the greater the point value of a fear of it.

Roll against Will when faced with the object of your fear. If you succeed, you will be at -2 IQ and -2 DX while the cause of your fear is present, and you must roll again every 10 minutes to see if the fear overcomes you. If you fail, you will react badly, running away, screaming, or freezing. Roleplay it!

Some common phobias: blood (hemophobia; *-10 points*); darkness (scotophobia; *-15 points*); dead bodies (necrophobia; *-10 points*); enclosed spaces (claustrophobia; *-15 points*); fire (pyrophobia; *-5 points*); heights (acrophobia; *-10 points*); loud noises (brontophobia; *-10 points*); open spaces (agoraphobia; *-10 points*); strange and unknown things (xenophobia; *-15 points*). See also p. 133.

Secret *-5/-10/-20/-30 points*

A Secret is an aspect of your life that you must keep hidden. The GM rolls three dice before every adventure. On a 6 or less, your Secret appears. It is not automatically made public; you will have the chance to keep the Secret from being revealed, although this might mean caving in to blackmail or extortion, stealing the incriminating evidence, silencing someone who knows the Secret, etc.

If you succeed, you get to keep your Secret. The solution, however, is only temporary; the Secret will appear again and again until you finally buy it off.

If you fail, and your Secret is made public, replace the Secret disadvantage with new disadvantages worth *twice* as many points as the Secret itself! The disadvantages acquired must be appropriate to the Secret, and are determined with the GM's assistance. Secrets usually turn into Enemies, bad Reputations, or Social Stigmas, or reduce your Status or wealth (going from Filthy Rich to Very Wealthy is effectively a -20-point disadvantage).

The point value of a Secret depends on the consequences if revealed: serious embarrassment (-5 points), utter rejection by society (-10 points), imprisonment or exile (-20 points), or possible death (-30 points).

Sense of Duty *-5/-10/-15/-20 points*

You suffer from a self-imposed feeling of duty. If you feel a sense of duty toward someone, you'll never betray him, abandon him when he's in trouble, or let him suffer if you can help. If you go against your sense of duty, the GM will penalize you for bad roleplaying.

You define the group toward which your character feels a sense of duty, and the GM sets its point value. *Examples:* close friends and companions (-5 points); a nation or other large group, such as "all humans" or "all AIs" (-10 points); everyone you know personally (-10 points); all sapient beings (-15 points); all life, digital or organic (-20 points).

Stubbornness *-5 points*

You always want your own way. Make yourself generally hard to get along with – roleplay it! Your friends may have to make a lot of Fast-Talk rolls to get you to go along with reasonable plans. Others react to you at -1.

Truthfulness *-5 points*

You hate to tell a lie – or you're just bad at it. To keep silent about an uncomfortable truth (lying by omission), make a Will roll. To *tell* a falsehood, roll at a -5 penalty! A failed roll means you blurt out the truth, or stumble so much that your lie is obvious.

Weak Will *-8 points/level*

You are easily persuaded, frightened, tempted, etc. Each level gives you a -1 to IQ when you make a Will roll (p. 231). This includes attempts to resist distraction, seduction, torture, etc. If your IQ is over 14, treat it as 14 *before* subtracting Weak Will; e.g., IQ 14+ and 3 levels of Weak Will would result in a Will roll of 11.

You cannot have both Strong Will and Weak Will.

Workaholic *-5 points*

You always work at least 50% more hours than normal. This often results in missed sleep (see *Fatigue,* pp. 237-238). As well, you cannot relax, and prioritize work over people. This gives a -1 or -2 to reaction rolls in situations where it would be apparent (GM's discretion).

Youth *-2 to -6 points*

You are 1 to 3 years "legally underage," at -2 points per year. You suffer a -2 reaction roll when you try to deal with others as an adult; they may like you, but they don't fully respect you. Laws may prevent you from signing contracts, voting, using drugs/nano/alcohol, owning/operating vehicles or weapons, etc. "Buy off" Youth when you reach "legal age" (usually 18).

QUIRKS

A "quirk" is a minor personality trait – not necessarily a disadvantage, just something unique about your character. For instance, Greed is a disadvantage. But if you insist on being paid in U.S. dollars, even in China, that's a quirk.

You may take up to five "quirks" at -1 point each. These do *not* count against the maximum number of disadvantage points allowed in your campaign.

A quirk *must* be something that can be roleplayed, or that will influence others' reactions in a significant way. If you take the quirk "dislikes heights," but blithely climb trees or cliffs whenever you need to, the GM will penalize you for bad roleplaying. Beliefs, goals, strong likes and dislikes . . . these *might* be quirks; "Likes VR games" is not a quirk, but "Talks constantly about VR games" can be.

SKILLS

A "skill" is a particular kind of knowledge. Karate, genetic engineering, and the English language are all skills.

Each of your skills is represented by a number called a *skill level;* the higher the number, the greater the skill. When you try to do something, you (or the GM) will roll 3 dice against the appropriate skill, modified as the GM sees fit for that particular situation. If the number you roll is *less than or equal to* your (modified) score for that skill, you succeed! But a roll of 17 or 18 is an automatic failure.

LEARNING SKILLS

To learn or improve a skill, you must spend character points. Skills are either *mental* or *physical.* The tables below show the point cost to learn each skill.

The first column shows the skill level you are trying to attain, *relative to the controlling attribute.* This is usually DX for physical skills and IQ for mental ones; exceptions are noted in individual skill descriptions. If your DX is 12, then a level of "DX-1" would be 11, "DX" would be 12, "DX+1" would be 13, and so on.

The remaining columns show the point costs to learn skills of different *difficulties – Easy, Average, Hard,* and *Very Hard* – at that level. Harder skills cost more character points to learn!

Physical Skills

Your Final Skill Level	*Difficulty of Skill* *Easy*	*Average*	*Hard*
DX-3	–	–	1/2 point
DX-2	–	1/2 point	1 point
DX-1	1/2 point	1 point	2 points
DX	1 point	2 points	4 points
DX+1	2 points	4 points	8 points
DX+2	4 points	8 points	16 points
DX+3	8 points	16 points	24 points
DX+4	16 points	24 points	32 points

Mental Skills

Your Final Skill Level	*Difficulty of Skill* *Easy*	*Average*	*Hard*	*Very Hard*
IQ-4	–	–	–	1/2 point
IQ-3	–	–	1/2 point	1 point
IQ-2	–	1/2 point	1 point	2 points
IQ-1	1/2 point	1 point	2 points	4 points
IQ	1 point	2 points	4 points	8 points
IQ+1	2 points	4 points	6 points	12 points
IQ+2	4 points	6 points	8 points	16 points

Further increases follow the same progressions: 8 additional points per level for physical skills, 4 per level for Very Hard mental skills, 2 per level for other mental skills.

LIMIT ON BEGINNING SKILLS

The *maximum* number of points a starting character can spend on skills depends on his age; see *Skills,* p. 136. This doesn't apply to skills gained in play (see *Character Improvement*, pp. 228-229). PCs built with ***GURPS Lite*** should not be over 70 (excluding time spent frozen, etc.); for aged PCs, see ***GURPS Basic Set***.

SKILL DEFAULTS

Most skills have a "default level" at which you perform the skill *without training.* Nobody can know every skill; a default roll can save your life. A skill has a default level if it's something anybody can do . . . a little bit.

For instance, the "default" for Camouflage is IQ-4. If your IQ is 11, and you must conceal yourself, you do it on a roll of 7 or less. Why? Because 11 minus 4 is 7, so 7 is your "default" skill at Camouflage. You smear dirt on your face and tie twigs to your hat; it may work!

Some skills (especially Very Hard ones) have *no* default.

LIST OF SKILLS

The entry for each skill gives the following information:

Name. Its name; e.g., "Armoury."

Type. Its class (mental or physical) and difficulty (Easy, Average, Hard, or Very Hard). Sometimes abbreviated; e.g., "M/A" for "Mental/Average."

Defaults. The attribute(s) to which the skill defaults if not known; e.g., "DX-6". If there's more than one possible default, use the one that gives the highest level.

Description. A *brief* description of what the skill is used for and when (or how often) to roll. The GM should permit routine tasks to be performed on a straight skill roll; more or less difficult tasks, or adverse or favorable conditions, will result in modifiers to skill (GM's discretion).

Acrobatics (Physical/Hard) DX-6

The ability to perform acrobatic and gymnastic stunts, roll, take falls, etc. A separate skill roll is required for each trick you attempt.

Acting (Mental/Average) IQ-5

The ability to counterfeit moods, emotions, and voices, and to lie convincingly over a period of time. Roll a Quick Contest versus the IQ of each person you wish to fool.

Administration (Mental/Average) IQ-6

The skill of running a large organization. A skill roll lets you deal with a bureaucracy quickly and efficiently.

Animal Handling (Mental/Hard) IQ-6

The ability to train and work with all types of animals. Daily rolls are required when training an animal.

Area Knowledge (Mental/Easy) IQ-4 for area residents only

The skill of familiarity with the people, politics, and geography of a given area. Roll for each piece of knowledge required.

Armoury (Mental/Average) IQ-5

The ability to build and repair weapons. Each class of weapons – e.g., artillery, small arms, and vehicular weapons – requires its own Armoury skill.

Bard (Mental/Average) IQ-5

The ability to speak extemporaneously and to tell stories. Also called *Public Speaking.* Roll once per speech or story.

Battlesuit (Physical/Average) DX-5 or IQ-5

The ability to wear a battlesuit (p. 160). If making DX rolls or using DX-based skills in a battlesuit, your effective DX or skill can't exceed Battlesuit skill.

Beam Weapons (Physical/Easy) DX-4

The ability to fire beam-projecting small arms. Each type of weapon requires its own Beam Weapons skill; see p. 136 and p. 156. Add 1 to skill for an IQ of 10-11, or 2 for an IQ of 12+.

Brain Hacking (Mental/Very Hard) Will-6

The ability to use specialized software to edit, interrogate, and modify captive digital minds. Roll once per attempt; failure may damage the mind.

Brawling (Physical/Easy) No default

The skill of unscientific unarmed combat. Roll against Brawling to hit with a punch, or Brawling-2 to hit with a kick, and add 1/10 your skill (round down) to damage. You may parry *barehanded* attacks at 2/3 skill.

Camouflage (Mental/Easy) IQ-4

The ability to use natural material or paints to disguise yourself, your equipment, your position, etc. Roll once per person, vehicle, or position hidden.

Carousing (Physical/Average) HT-4

The skill of drinking, partying, etc. A successful skill roll gives you +2 reaction rolls in such circumstances; failure gives a -2 instead. This skill is based on HT, not DX.

Climbing (Physical/Average) DX-5 or ST-5

The ability to climb mountains, ropes, the sides of buildings, trees, etc. Roll once to start a climb; long climbs may require more rolls. See p. 229.

Computer Skills (Mental/Varies) Defaults vary

Skill in using computers. Roll once per important programming, hacking, or data-recovery attempt. No roll is needed for routine use.

Artificial Intelligence (M/H): The ability to train or design AIs. No default.

Computer Hacking (M/VH): The ability to break into computer systems. This is often *impossible* unless *some* clues (partial passwords, "back doors," etc.) are known. No default.

Computer Operation (M/E): The ability to call up or recover lost data, use common operating systems, play games, etc. Defaults to IQ-4.

Computer Programming (M/H): The ability to write and debug computer programs. No default.

Cooking (Mental/Easy) IQ-4

The ability to prepare a pleasing meal from basic ingredients. Roll once per meal.

Criminology (Mental/Average) IQ-4

The study of crime and the criminal mind. Roll to find and interpret clues, guess how criminals might behave, etc.

Demolition (Mental/Average) IQ-5

The ability to blow things up with explosives. A Demolition roll is necessary to safely use explosives.

Diagnosis (Mental/Hard) IQ-6

The ability to tell what is wrong with a sick or injured person, or what killed a dead person. Roll once per diagnosis.

Disguise (Mental/Average) IQ-5

The ability to make yourself look like someone else. Roll a Quick Contest of Skills (Disguise vs. IQ) for each person (or group) that your disguise must fool.

Electronics Operation (Mental/Average) IQ-5

The ability to *use* electronic gear. No skill roll is required for normal, everyday use of equipment, only for complex or emergency situations. Each category of gear – communications, medical, security systems (includes electronic lock-picking), sensors – requires its own Electronics Operation skill.

Engineering Skills (Mental/Hard) No default

The ability to design and build electronic apparatus (Electronics skills) or complex machinery (Engineer skills). Each class of electronic equipment (communications, sensors, etc.) is a separate Electronics skill; each field of engineering (civil, computers, mining, etc.; see p. 136) is a separate Engineer skill. A successful roll will let you identify the purpose of a strange device, diagnose a glitch, perform a repair, or design a new system.

Escape (Physical/Hard) DX-6

The ability to get free from ropes, handcuffs, and similar bonds. The first attempt to escape takes one minute; each subsequent attempt takes 10 minutes.

First Aid (Mental/Easy) IQ-5

The ability to patch up an injury in the field (see p. 236). Roll once per injury.

Forensics (Mental/Hard) No default

The general science of "laboratory" criminology. Roll to analyze each piece of physical evidence.

Forgery (Mental/Hard) IQ-6 or DX-8

The ability to produce fake passports, identity papers, or similar documents. Roll once per forgery. See p. 136.

Free Fall (Physical/Average) DX-5 or HT-5

The ability to handle yourself in zero- or microgravity; see pp. 54-56.

Freight Handling (Mental/Average) IQ-5

The ability to load and unload cargo quickly and efficiently. A successful skill roll will reduce the time required for such tasks by 25%.

Gambling (Mental/Average) IQ-5

The skill of playing games of chance. A successful Gambling roll can tell you if a game is rigged, identify a fellow gambler in a group of strangers, or "estimate the odds" in a tricky situation.

Genetics (Mental/Very Hard) No default

Skill in genetics theory or genetic engineering. Each genetic science is a separate skill; see p. 136. Roll once per research or engineering task.

Gunner (Physical/Average) DX-5

The ability to fire vehicular or tripod-mounted heavy weapons. Each type of weapon requires its own Gunner skill. Options include beams (lasers and particle beams), cannon (autocannon and tank guns), guided missile, machine gun (heavy automatic weapons), and railgun (including coilguns). Add 1 to Gunner skill for an IQ of 10-11, or 2 for an IQ of 12+.

Guns (Physical/Easy) DX-4

The ability to shoot projectile-firing small arms. Each type of weapon requires its own Guns skill; see p. 136 and p. 156. Add 1 to Guns skill for an IQ of 10-11, or 2 for an IQ of 12+.

Hand Weapon (Physical/Varies) Defaults vary

Each class of hand weapons requires a separate physical skill; roll against this skill when attacking. Most hand weapons may also *parry* (p. 233); this is done at 1/2 skill unless noted. Assume that P/E weapon skills default to DX-4 and P/A ones default to DX-5. Skills include:

Knife (P/E): Any kind of fighting knife or short, unfixed bayonet.

Shortsword (P/A): Any 1- to 2-foot balanced, one-handed weapon, such as a police baton or a machete.

Two-Handed Axe/Mace (P/A): Any long, unbalanced, two-handed weapon, such as a shovel, or a heavy rifle or machine gun gripped by the barrel.

Holdout (Mental/Average) IQ-5

The skill of concealing items on your person or on others, or finding such hidden items. Roll once per item.

Humanities (Mental/Hard) IQ-6

Each academic "humanities" or "arts" subject (such as History, Literature, Philosophy, or Theology) is a separate Mental/Hard skill that defaults to IQ-6. Roll versus skill to recall references, perform critical analysis, etc.

Influence Skills (Mental/Varies) Defaults vary

There are several ways to influence others; each is a separate *influence skill.* A successful roll will result in a "good" reaction from an NPC. Failure results in a "bad" reaction (except for Diplomacy, which is always safe). To actually coerce or manipulate an NPC, you must win a Quick Contest of your skill versus his Will. Methods of influencing others include:

Diplomacy (M/H): Negotiation and compromise. Defaults to IQ-6.

Fast-Talk (M/A): Lies and deception. Defaults to IQ-5.

Intimidation (M/A): Threats and violence. Defaults to ST-5.

Savoir-Faire (M/E): Manners and etiquette. Mainly useful in "high society" situations. Defaults to IQ-4.

Savoir-Faire (Military) (M/E): Military protocol and the "old boy" network. Only useful in military situations. Defaults to IQ-4.

Sex Appeal (M/A; based on HT, not IQ): Vamping and seduction, usually of the opposite sex. Defaults to HT-3.

Streetwise (M/A): Contacts and (usually) subtle intimidation. Only useful in "street" and criminal situations. Defaults to IQ-5.

Intelligence Analysis (Mental/Hard) IQ-6

Interpreting intelligence reports and analyzing raw reconnaissance data. On successful roll, the GM might grant you additional information about enemy actions, provided the data was reliable.

Interrogation (Mental/Average) IQ-5

The ability to question a prisoner. To do so, you must win a Contest of Skills: your Interrogation skill vs. the prisoner's Will.

Judo (Physical/Hard) No default

Formal training in locks and throws. If you have empty hands and no more than light encumbrance, you may parry attacks (even weapons) at 2/3 skill. On the turn after a successful parry, you may attempt to throw your opponent. This counts as an attack, and is rolled against Judo skill. If your foe does not dodge or parry, he is thrown to the ground.

Karate (Physical/Hard) No default

The skill of *trained* punching and kicking. When you punch or kick, use Karate skill rather than DX to determine the odds of hitting, and add 1/5 of your skill level (round down) to damage. You may also parry attacks (even weapons) at 2/3 skill. Your encumbrance must be light or less to use Karate.

Law (Mental/Hard) IQ-6

A successful Law roll lets you remember, deduce, or figure out the answer to a question about the law. An actual trial is handled as a Contest of Law skills.

Leadership (Mental/Average) ST-5

The ability to coordinate a group in a stressful situation. Roll to inspire NPCs to follow you into or to endure danger (e.g., combat).

Mathematics (Mental/Hard) IQ-6

Formal training in higher mathematics. A successful skill roll will let you answer the sorts of mathematical questions likely to matter on an adventure.

Mechanic (Mental/Average) IQ-5

The ability to diagnose and fix ordinary mechanical problems. Roll once per diagnosis or repair. Each category of machine requires its own Mechanic skill; see p. 136.

Merchant (Mental/Average) IQ-5

The ability to act as a "trader," buying and selling merchandise. A successful skill roll lets you judge the value of common goods, locate markets, etc.

Meteorology (Mental/Average) IQ-5

The study of the weather and the ability to predict it, given the appropriate instruments. Roll once per prediction.

Musical Instrument (Mental/Hard) No default

The ability to play a musical instrument. Each instrument is a separate version of this skill. Roll once per performance.

Natural Sciences (Mental/Varies) Defaults vary

Each specialty (e.g., Astronomy, Botany, Chemistry, Ecology, Geology, Physics, or Zoology) is a separate Mental/Hard skill that defaults to IQ-6, with the exceptions of Biochemistry and Nuclear Physics, which are Mental/Very Hard skills with no default. Roll versus skill to recall general knowledge within the field, analyze data, perform lab work, and so on.

Navigation (Mental/Hard) No default

The ability to find position by the stars, ocean currents, etc. Whether you are on land, at sea, or in the air, a successful roll will tell you where you are.

NBC Warfare (Mental/Average) IQ-5

Expertise with the gear used in nuclear, biological, or chemical (NBC) warfare or biohazard environments. If proper equipment is available, roll against skill to safely detect and neutralize contaminants. See also p. 136.

Parachuting (Physical/Easy) DX-4 or IQ-6

The ability to parachute jump. Failure means a drift off course or dropped gear. A critical failure is potentially fatal! A second roll is required to dodge trees, avoid injury, etc. in a rough landing zone.

Physician (Mental/Hard) IQ-7

The general professional ability to aid the sick, prescribe drugs and care, etc. This is the skill to use if the GM requires a single roll to test general medical competence or knowledge.

Pickpocket (Physical/Hard) DX-6

The ability to steal a small object (purse, knife, etc.) from someone's person. Roll once per theft; if the target is alert, treat this as a Quick Contest vs. the target's IQ.

Politics (Mental/Average) IQ-5

The ability to run an election campaign, stay abreast of politics, and get along with politicians. A successful roll will give you a +2 reaction from a politician. A campaign will involve Contests of Politics skills.

Prospecting (Mental/Average) IQ-5

The skill of finding valuable minerals by on-site examination or via instruments.

Research (Mental/Average) IQ-5

General skill at library research. A successful Research roll in an appropriate place of research will let you find a useful piece of data, if that information is to be found.

Scrounging (Mental/Easy) IQ-4

The ability to find or salvage useful items. A successful skill roll will locate the item desired, if the GM rules that it is there in the first place.

Shadowing (Mental/Average) IQ-6

The ability to follow another person through a crowd without being noticed. Roll a Quick Contest of Skill every 10 minutes: your Shadowing vs. the subject's Vision roll. If you lose, you lose the target – or he spots you!

Social Sciences (Mental/Hard) IQ-6

Each "social science" (e.g., Anthropology, Archaeology, Economics, Psychology, or Sociology) is a separate Mental/Hard skill that defaults to IQ-6. Roll versus skill to recall general knowledge within the field, identify traits that characterize an individual, culture, or society (as applicable), and so on.

Stealth (Physical/Average) IQ-5 or DX-5

The ability to hide and to move silently. Roll a Quick Contest of Skills between your Stealth and the Hearing roll of anyone you're trying to hide from.

Surgery (Mental/Very Hard) No default

The ability to perform operations (including installing/removing implants). Roll once per operation; failure may inflict 1d to 3d damage!

Survival (Mental/Average) IQ-5

The ability to "live off the land," find food and water, avoid hazards, build shelter, etc. A different Survival skill is required for each terrain type. Roll once per day in a wilderness situation.

Swimming (Physical/Easy) ST-5 or DX-4

This skill is used both for swimming and for saving a drowning victim. Roll once per swim, dive, or lifesaving attempt.

Tactics (Mental/Hard) IQ-6

The ability to plan small battles, with up to a few dozen combatants. A skill roll may give insight into enemy plans (GM's option).

Teaching (Mental/Average) IQ-5

The ability to instruct others. The GM may require one or more skill rolls to teach another character a skill.

Throwing (Physical/Hard) No default

The ability to throw whatever you can pick up. It helps both accuracy (roll against Throwing skill to throw anything you can lift) and distance (add 1/6 of Throwing skill to ST when determining distance). Roll once per throw.

Thrown Weapon (Physical/Easy) DX-4

The ability to throw any one type of *throwable* weapon. This skill is different for each type of weapon: Grenade Throwing, Knife Throwing, etc.

Tracking (Mental/Average) IQ-5

The ability to follow a man or an animal by its tracks. Make one Tracking roll to pick up the trail, and one further roll per 5 minutes of travel.

Vacc Suit (Mental/Average) IQ-6

The ability to don a spacesuit quickly, work comfortably in it, and swiftly patch any holes.

Vehicle Skills (Physical/Varies) Defaults vary

Each class of vehicle requires its own operation skill. Roll once to get under way and again each time a hazard is encountered, or during a high-speed chase. Failure indicates lost time, or an accident. Vehicle skills default to DX at -4 (Easy) or -5 (Average); *motor* vehicles also default to IQ, at similar penalties. Available types include *Bicycling (P/E), Boating (P/A)* (for rowboats and sailboats), *Driving* (P/A) (separate versions for cars, tanks, trucks, etc.), *Motorcycle (P/E), Piloting (P/A)* (separate versions for light and heavy propeller craft, jets, helicopters, vertical-takeoff air cars, gliders, and spacecraft; see p. 137), and *Powerboat (P/A)* (for motorboats and mini-subs).

Writing (Mental/Average) IQ-5

The ability to write in a clear or entertaining manner. Roll once per article, or daily for long works.

Xenobiology (Mental/Average) No default

Knowledge of extraterrestrial biochemistry; each specialty (see p. 137) is a different skill. Roll to recall general knowledge within the field, analyze data, do lab work, etc.

LANGUAGES

Languages are treated as skills. The *Language Talent* advantage (p. 216) makes it easier to learn languages.

Language Skills (Mental/Varies) No default

Each language is a separate mental skill. Your native language skill starts out equal to your IQ, and costs only 1 point per level to improve. Other languages are improved like any other skill. Difficulty of languages varies:

Easy: Pidgins and the like.

Average: Most languages – French, German, Mandarin Chinese, etc.

Hard: A rare few languages, such as Basque or Navajo.

Any conversation depending on a language not native to all parties requires a roll against skill to understand or be understood.

RACIAL TEMPLATES

The character-creation rules described up to this point apply to ordinary "baseline" humans; however, many characters in a ***Transhuman Space*** game will be more than human. To create such a character, select a *racial template* (or *two* templates, if an infomorph) from those detailed on pp. 114-126.

A racial template is a package of attribute modifiers (see below), advantages, disadvantages, and features (0-point traits). Each template has a racial point cost listed, which is the sum of the individual point costs for the traits listed as making up the template. (These individual costs are listed in the template, in brackets – [ ] – for reference.) For example, the Alpha Upgrade on p. 115 has a racial point cost of 35 points.

If you choose a racial template (or two templates, if you are an infomorph), you treat the template's point cost as if it were an advantage (if positive) or disadvantage (if negative). If it's a disadvantage, it doesn't count against the disadvantage limit for your campaign.

When you take a racial (or model) template, all the attribute modifiers, advantages, and disadvantages in the template apply automatically to your character. Don't take any advantages or disadvantages that duplicate them!

Attribute Modifiers: Most racial templates have one or more *attribute modifiers*; e.g., DX +2 or IQ -1. After you buy your character's attributes (p. 210), you apply the attribute modifiers in your template(s). This may raise or lower your attributes, but you don't pay any points (or get any points back) for this, since the cost was already included in the cost of the template. For example, if you buy DX 13 for 30 points and your template gives DX +2, you would have DX 15 at no additional cost.

Racial Advantages and Disadvantages: These can include normal advantages and disadvantages (pp. 210-219), as well as special "racial and super" advantages and disadvantages that are not found in ordinary humans (see below). They also include the occasional *racial skill bonus* (e.g., "Free Fall +3") that gives a bonus to a specific skill if at least 1/2 point is paid to learn that skill.

RACIAL AND SUPER ADVANTAGES

Brief descriptions are given here; for more detail, see ***GURPS Compendium I.*** Point cost is noted for reference.

Amphibious: You are at home in the water, and can swim at full Move without Swimming skill. *10 points.*

Catfall: You subtract 5 yards from any fall. A DX roll *halves* all damage taken from a fall. *10 points.*

Chameleon: You blend into your surroundings: +2/level to Stealth if still, half that if moving. *7 points/level.*

Claws: You have claws that give +2 damage with a punch or kick. *15 points.*

Clinging: You can climb walls and ceilings like an insect. *25 points.*

Damage Resistance: You have one or more points of DR. *3 points/level.*

Discriminatory Smell: You have a bloodhound's olfactory abilities, and +4 to smell Sense rolls. *15 points.*

Doesn't Breathe: You cannot drown or be poisoned by inhaled gas. *20 points.*

Drug Factory: Your body manufactures drugs. You can dispense up to (HT/2) doses daily by bite or claws. *20 points (first drug) + 10 points/extra drug.*

Early Maturation: Each level halves the age at which you reach maturity (normally 18). *5 points/level.*

Enhanced Move: Each level increases Move by your original Move score in one means of locomotion, if moving in a relatively straight line and not dodging. *10 points/level.*

Enhanced Time Sense: You process information inhumanly fast. You get Combat Reflexes, and automatically have initiative in combat (if an opponent has this advantage also, break ties by highest Basic Speed). The GM will give you extra time to think about an action, rather than requiring rapid decisions. *45 points.*

Extended Lifespan: Each level halves the rate at which you age. *5 points/level.*

Extra Arms: You have multiple arms, or "feet manipulators" that can double as arms. You can still only make one attack per turn. *10 points/arm.*

Extra Fatigue: Increase your ST by +1/level for the purpose of taking fatigue (only). *3 points/level.*

Extra Flexibility: You have tentacles or similar limbs with a larger movement arc than human arms. *10 points.*

Extra Hit Points: Increase your HT by +1/level for the purpose of determining how many hits you can sustain (only). *5 points/level.*

Extra Legs: You have extra legs; you can lose some and still walk. *Cost varies.*

Extra Life: You can return from the dead . . . once. *25 points.*

Faz Sense: You can sense moving objects via air motion at short range (e.g., in the same room). *10 points.*

Filter Lungs: You can safely breath airborne toxins or contaminants. *5 points.*

Flexibility: Similar to Double-Jointed (p. 215), but more extreme: +5 to Climbing, Escape, or Mechanic. *15 points.*

Flight: You can fly at twice your Move. *40 points.*

Fur: You stay warm and have DR 1. *4 points.*

Hermaphromorph: You can voluntarily change sex (takes six hours). *2 points.*

Hyper-Reflexes: You can "activate" Combat Reflexes and a +1 Speed bonus (if you already have Combat Reflexes, double its benefits) at a cost of 1 fatigue point/turn. *15 points.*

Hyper-Strength: You can "activate" a +50% ST increase at a cost of 1 fatigue point/turn. *30 points.*

Immunity to Poison: Drugs and poisons do not affect you. *15 points.*

Increased Speed: Gives +1/level to Basic Speed and Move. *25 points/level.*

Infravision: You can see in the dark using thermal imaging. The shapes of people and objects stand out against cooler or warmer backgrounds. Gives +2 to see (or +3 to track) living beings. *15 points.*

Injury Tolerance: You lack a specific brain (No Brain), or don't bleed (No Blood), or can't be strangled (No Neck). *5 points each.*

Microscopic Vision: Your eyes magnify tiny, close-up details. Each level doubles magnification. *4 points/level.*

Move Through Ice: You melt or burrow through ice at your full Move. *10 points.*

Oxygen Storage: You can store an hour's worth of oxygen in your body. *14 points.*

Passive Defense: Your body gives 1 PD per level (up to PD 6), if you don't wear armor. *25 points/level.*

Penetrating Vision: You can see through 6" of solid matter/level. *10 points/level.*

Perfect Balance: You can move like a squirrel and run along branches, high wires, etc. with ease. Gives +1 to Acrobatics, Climbing, and Piloting skills. *15 points.*

Polarized Eyes: Flashes or bright light don't blind you. *5 points.*

Radar Sense: You have built-in radar that lets you see objects all around you, ignoring penalties for darkness, smoke, etc. *50 points + 1 point/yard of range.*

Radio Speech: You can communicate by radio (see p. 130). *25 points.*

Sanitized Metabolism: You never have body odor, acne, or bad breath. Gives +1 to reaction rolls, where appropriate. *5 points.*

Secret Communication: You have an undetectable, unjammable means of communication. *20 points.*

Sensitive Touch: Your fingers can recognize faces, read newsprint, etc. *10 points.*

Sharp Claws: Your kicks or punches do cutting damage. *25 points.*

Sharp Teeth: You can bite for thrust/cutting damage in close combat. *5 points.*

Silence: You add +2/level to Stealth if still, +1/level if moving. *5 points/level.*

Sonar Vision: You "see" by emitting sound waves, with a range of 100 yards in air or 1/2 mile in water. *25 points (0 if* ***instead*** *of vision).*

Special Rapport: You can sense what a specific individual is feeling, or if he's in pain. *10 points/individual.*

Spectrum Vision: You can detect radio, radar, and other electromagnetic emissions. Includes Infrared Vision, above. *40 points.*

Super Flight: Each level *doubles* flying speed. Requires Flight. *20 points/level.*

Telescopic Vision: You can see as if using binoculars. Each level doubles magnification. *6 points/level.*

Tunnel: You can move through earth or rock at the listed speed in yards per second. *40 points + 10 points/yard per second.*

Unaging: You don't age. *15 points.*

Vacuum Support: You can survive in space, underwater, or without oxygen as if wearing a vacc suit with an unlimited air supply. *40 points.*

Visualization. By visualizing success at a noncombat task, you can improve your odds. Concentrate for one minute, describe the task, and make a Will roll. You get +1 to the actual task per two points by which you beat your Will. *10 points.*

RACIAL AND SUPER DISADVANTAGES

Dependency (Maintenance): You need periodic tune-ups or refueling, or you'll stop working. *Cost varies.*

Extra Sleep: You need more hours of sleep each night. *-3 points/hour.*

Inconvenient Size: You are substantially larger (over 8' tall) or smaller (under 2') than a human. *-10 (larger) or -15 (smaller) points.*

Invertebrate: You can squeeze into small spaces, but your lifting/dragging ST is 25% of normal. *-20 points.*

No Manipulators: You have no arms. *-50 points.*

One Fine Manipulator: You have only one functional arm, and you can't do things that need two hands. In borderline cases, the GM applies a -4 penalty. *-15 points.*

Parasite: You are dependent on a host to live, and die if he dies. *Cost varies.*

Reduced Hit Points: Reduce your HT by -1/level for the purpose of determining how many hits you can sustain (only). *-5 points/level.*

Reprogrammable Duty: You can be programmed to obey a particular master. *-25 points.*

Sessile: You cannot move under your own power! *-50 points.*

Slave Mentality: You show no self-initiative at all. Roleplay it! *-40 points.*

Sterile: You cannot reproduce. *-3 points.*

Unhealing: You cannot heal without physical repairs. *-20 points.*

ENHANCEMENTS AND LIMITATIONS

Enhancements increase a given advantage or disadvantage's effect, and also increase point cost by a listed percentage; the reverse is true of *limitations*. Most are self-explanatory; others are covered in Chapter 4.

EQUIPMENT

Now you need to decide what equipment you have. See Chapter 5 for available gear. Weapons and armor are a special case, however, since their use involves more intricate game mechanics. This section will give you enough information to let you choose your combat gear intelligently.

A Note on Buying Things: You start with money equal to the standard starting wealth, modified by your wealth level (see pp. 213-214). Subtract the price of each item you buy from your starting wealth to determine how much money you have left. In some cases – e.g., a military or spy campaign – equipment will be *issued.* This means it does not have to be paid for out of your pocket; however, it does not really belong to you, and can always be taken away.

ARMOR

Armor protects you in two ways (in both cases, higher numbers are better):

Passive Defense (PD): Adds to your defense roll while you wear the armor, and represents the fact that some attacks are deflected by the armor's shape. PD ranges from 1 to 6.

Damage Resistance (DR): The number of hits subtracted from an attack that strikes you. For instance, if you are hit while wearing DR 15 armor, and the attacker rolls 19 points of damage, only 4 hits affect you.

OTHER ADVANTAGES, DISADVANTAGES, AND SKILLS

Some advantages, disadvantages, and skills referenced in ***Transhuman Space*** don't appear in ***GURPS Lite***. These are detailed in ***GURPS Basic Set*** and ***Compendium I.*** When using ***GURPS Lite,*** the GM may adjudicate their effects, or substitute others of similar cost from those included here.

HAND WEAPON TABLE

Weapons are listed in groups, according to the skill required to use them. Weapons that can be used in two ways (for instance, a saber can either cut or impale) have two lines – one for each type of attack.

Type is the type of damage the weapon does (see below).

Damage is the die roll (p. 207) for the damage done to the target.

Reach indicates the distance in yards at which the weapon can be used; *C* indicates a close-combat weapon. Reach is not used in ***GURPS Lite,*** but GMs may find it useful when judging what can and cannot be hit with a hand weapon.

Min ST is "minimum strength." If you are weaker than this, your skill is at -1 for every point of difference.

Weapon	*Type*	*Damage*	*Reach*	*Cost*	*Weight*	*Min ST*	*Special Notes*
KNIFE (DX-4)							
Bayonet or Combat Knife	cut	sw-2	C, 1	$40	1 lb.	–	Maximum damage 1d+2.
	imp	thr	C				Maximum damage 1d+2.
SHORTSWORD (DX-5)							
Baton	cr	sw	1	$20	1 lb.	7	
	cr	thr	1				
Machete	cut	sw+1	1	$75	3 lbs.	10	A tool; -1 to hit as a weapon.
TWO-HANDED AXE/MACE (DX-5)† *Requires two hands.*							
Shovel	cr	sw+2	1, 2*	$30	6 lbs.	13	1 turn to ready. Tool; -1 to hit as a weapon.
	cut	sw+2	2*				1 turn to ready. -3 to hit with sharp edge.
Swung Rifle, Pipe, etc.	cr	sw+2	1	–	–	12	1 turn to ready. A rifle used as a club.

* Must be *readied* for one turn to change from long to short grip or vice versa.

† Becomes unready if used to parry.

PD, DR, weight in lbs., and cost in $ are given for each piece of armor listed on pp. 159-161. ***GURPS Lite*** does not include a system for assessing damage to specific body parts, but use common sense; e.g., a helmet would help against a falling brick, while a vest would not.

WEAPONS

Guns work for anyone who knows how to use them. Hand weapons, such as clubs and knives, do more damage when wielded by a strong person.

Basic Weapon Damage

Basic damage is the penetrating damage a weapon does, before any special modifiers for damage type (below). Your basic damage with hand weapons depends on your ST. Damage is shown as "dice+adds" (see p. 207). For example, "2d+1" means you roll two dice and add 1 to the result. Thus, a roll of 7 would mean 8 hits of damage.

Hand-Weapon Attacks

There are two types of hand-weapon attack: *thrusting* and *swinging*. A swinging attack does more damage: the weapon acts as a lever to multiply your ST. The table below shows how much basic damage each type of weapon does, according to the user's ST. The columns show the number of dice rolled to determine damage.

Damage Types and Damage Bonus

Attacks do three basic types of damage: *impaling, cutting,* and *crushing.*

Impaling attacks include stabbing weapons and laser beams. Damage that gets through DR is *doubled.*

Cutting attacks strike with a sharp edge. Damage that penetrates DR is *increased by 50%,* rounded down.

Crushing attacks strike with a blunt surface. They score no bonus damage. *Bullets* are treated as crushing attacks (but see p. 157).

Certain hand weapons can be used in different ways. For instance, some knives can be swung for a cutting attack or thrust for an impaling attack. Before you strike with such a weapon, you must specify how you are attacking.

Minimum Damage: If the basic damage rolled for a cutting or impaling attack, or a bullet, is 0 or less, treat it as 1 hit. Thus, if you strike with a knife for "1d-4" damage, and roll a 2, you still do 1 hit of damage (although armor may reduce this to 0). However, crushing attacks other than bullets *can* do zero damage.

Maximum Damage: Some weapons, especially impaling weapons, can only do so much damage on any one blow, no matter how strong the user is.

BASIC DAMAGE

ST	Thrusting	Swinging
4 or less	0	0
5	1d-5	1d-5
6	1d-4	1d-4
7	1d-3	1d-3
8	1d-3	1d-2
9	1d-2	1d-1
10	1d-2	1d
11	1d-1	1d+1
12	1d-1	1d+2
13	1d	2d-1
14	1d	2d
15	1d+1	2d+1
16	1d+1	2d+2
17	1d+2	3d-1
18	1d+2	3d
19	2d-1	3d+1
20	2d-1	3d+2
30	3d	5d+2
40	4d+1	7d-1
50	5d+2	8d-1

Recording Weapon Stats

Damage is copied from the weapon tables. To calculate hand-weapon damage, start with your basic damage for that type of attack, and then add the damage shown on the table for your weapon. If your ST is 10, your basic swinging damage is 1d; therefore, if a weapon does "sw+1," your damage with that weapon is 1d+1. High-tech weapons such as guns inflict damage independent of user ST.

Cost and *Weight* are copied directly from the weapon tables onto your character sheet.

Minimum Strength is the minimum ST needed to use the weapon properly. For every point of ST by which you are too weak, you will be at -1 to your weapon skill.

Ranged Weapons Statistics: If you have a ranged weapon, copy the stats from the appropriate weapon table (thrown weapons are given here; guns appear on p. 156). A number of specialized statistics are used for ranged combat; these are explained on p. 234.

SPEED, ENCUMBRANCE, AND MOVE

Speed

Your *Speed* score (or *Basic Speed)* determines your reaction time and running speed. It is figured from your HT and DX, and shows how fast you can run without encumbrance (see below). An average person has a Speed of 5 – that is, with no encumbrance, he runs about 5 yards per second.

Add your HT and DX together. Divide the total by 4. The result is your Basic Speed score; don't round it off! For instance, if your Basic Speed is 5.25, your unencumbered movement is 5 yards per second. But there will be times when a 5.25 is better than a 5!

Encumbrance

Your *encumbrance* is the total weight you are carrying. Encumbrance reduces your combat movement rate. It also slows long-distance travel, and makes swimming and climbing more difficult; see *Physical Feats* (pp. 229-230).

Your *encumbrance level* is a measure of that weight relative to your strength. A strong person can carry more than a weak one; therefore, the ratio of weight to strength determines encumbrance level, as follows:

Weight up to 2×ST: no encumbrance. You have no penalty.

Weight up to 4×ST: light encumbrance. Movement penalty of 1.

Weight up to 6×ST: medium encumbrance. Movement penalty of 2.

Weight up to 12×ST: heavy encumbrance. Movement penalty of 3.

Weight up to 20×ST: extra-heavy encumbrance. Movement penalty of 4. You cannot carry a weight more than 20 times your ST for more than a few feet at a time; 30 times ST is the absolute most you can carry.

Move

Your *Move* is the distance (in yards) you can run in one second. To find your Move, add up the total weight of all your equipment and find your encumbrance level. Now subtract the movement penalty from your Speed score, and round *down*. The result is your Move score – always a whole number, never a fraction. Move controls:

1. How fast you can move.

2. When you move in combat.

3. Your Dodge defense (p. 233). This *active defense* is equal to your Move.

Your Move can never be reduced to 0 unless you are unconscious, unable to use your legs, or lifting over 30 times your ST.

CHARACTER IMPROVEMENT

At the end of each session, the GM may award *bonus character points* for good play; these are the same kind of points used to create your character. "Good play" is anything that advances your mission or shows good roleplaying (including adhering to your disadvantages and quirks) – preferably both.

Bonus points are awarded separately to each character. A typical award is 1-3 points, with 5 points being the upper limit for *amazing* play. Bonus points are used to develop and improve your character. Record them as "unspent" on your character sheet. Spend them the same way as during character creation, with these differences:

THROWN WEAPON TABLE

Weapons are listed in groups, according to the skill required to use them. See p. 234 for an explanation of SS, Acc, 1/2D, and Max; for now, simply note them on your character sheet.

Weapon	*Type*	*Damage*	*SS*	*Acc*	*1/2D*	*Max*	*Cost*	*Weight*	*Min ST*	*Special Notes*
KNIFE THROWING (DX-4)										
Combat Knife	imp	thr	12	0	ST-2	ST+5	$40	1 lb.	–	Max. dam. 1d+2.
DX-3 OR THROWING SKILL										
Hand Grenade	varies	varies	12	0	–	ST × 3	varies	0.1 lbs.	–	See pp. 235-236.

Attributes: To improve one of your attributes (ST, DX, IQ, or HT), you must spend character points equal to *twice* the beginning point-cost difference between the old score and the new one. E.g., to go from ST 10 (beginning cost 0) to ST 11 (beginning cost 10) would cost 20 points.

If you improve an attribute, all skills based on that attribute also go up by the same amount.

Advantages: Most advantages are inborn, and cannot be "bought" later on. Exceptions include Combat Reflexes, which can be learned, and social advantages such as Military Rank, which can be earned. To add an advantage, you must pay the appropriate character points.

Buying Off Disadvantages: No character may get extra points by adding disadvantages after he is created. However, you may *get rid* of most beginning disadvantages by "buying them off" with points equal to the bonus earned when the disadvantage was taken, if you and the GM can agree on a *logical* explanation for this.

Adding and Improving Skills: Earned character points can be used to increase your skills or add new ones. Normally, these must be skills that, in the GM's opinion, were significantly used in the adventure in which those character points were earned. When you improve a skill, the cost is the difference between the cost of your current skill level and the cost of the new skill level.

CREATING NPCs

The GM creates all NPCs. Those who are likely to oppose or befriend the PCs should be created in advance. A group of thugs might share a single set of statistics, minor NPCs can be made up on the fly, and casual encounters might not even need stats. NPCs are built using the same rules as PCs, but often with lower point totals.

PLAYING THE GAME

We've seen the rules for creating characters. Now here's how to *do* things. Essentially, the GM describes a situation and asks each of the players what his character is doing. The players answer, and the GM tells them what happens next. At some point, the GM won't be certain that the characters can automatically do what the players say they are doing . . . "You're trying to reprogram the cybershell before the cops arrive?" . . . and the dice come out.

PHYSICAL FEATS

CLIMBING

Climbing speed on a ladder is about 3 rungs/second up, or 2 rungs/second down. To climb anything more difficult than a ladder, a Climbing roll is required. One roll is required to start the climb, with a further roll every five minutes; a failed roll means you fall. Modifiers to the roll depend on the difficulty of the climb; e.g., +5 for an ordinary tree (1 foot/second), no modifier for a typical cliff (1 foot/2 seconds), and -3 for a modern building (1 foot/10 seconds). Encumbrance level is subtracted from your Climbing skill.

HIKING

Distance traveled on foot in one day is a direct function of encumbrance. Under ideal travel conditions, a party in good shape may plan on traveling 50 miles a day with no encumbrance. Subtract 10 miles per day per level of encumbrance above that; e.g., a party at medium encumbrance travels 30 miles/day. The party's speed is that of its *slowest* member.

Once ideal daily mileage is determined, apply a multiplier for terrain:

Very Bad Terrain (deep snow, dense forest, jungle, mountains, soft sand, swamp): ×0.20.

Bad Terrain (broken ground, craters, forest, steep hills, streams): ×0.50.

Average Terrain (light forest, rolling hills, solid ice, dirt roads): ×1.00.

Good Terrain (hard-packed desert, level plains, good roads): ×1.25.

JUMPING

Usually, when you want to jump over something, the GM should say "OK, you jumped over it," and get on with play. In combat, jumping over an "ordinary" obstacle costs 1 extra yard of movement but is automatically successful. Only when the obstacle is significant should you resort to math to see if the character made the jump! Your ST score determines the maximum distance you can jump:

High Jump: (3×ST)-10 inches. Add 2 feet to this if you have 4 yards for a running start.

Standing Broad Jump: (ST-3) feet.

Running Broad Jump: As above, but add 1 foot for every yard of "takeoff" distance, up to double your standing broad jump distance.

LIFTING AND MOVING THINGS

In general, the GM may let characters lift whatever they need to, without die rolls; but when very heavy weights are involved, a check against ST may be needed. ST also governs the maximum weight you can lift:

One-Handed Lift: 6×ST pounds.

Two-Handed Lift: 25×ST pounds.

Carry on Back: 30×ST pounds. Thus, you can carry more than you can lift by yourself. (However, every *second* you carry more than 20×ST pounds, you lose one *fatigue* point; see pp. 237-238.)

Shove and Knock Over: 25×ST pounds, or 50×ST pounds with a running start.

Shift Slightly: 100×ST pounds.

Drag: On a rough surface, you can drag only about as much as you can carry. If you are dragging something on a smooth, level surface, halve its effective weight.

Pull on Wheels: As for dragging, but divide effective weight by 10 for a two-wheeled cart, or by 20 for a four-wheeled conveyance. Halve effective weight again if it is being pulled on a good road.

Picking Things Up in Combat: In combat, a light item is picked up with the Ready maneuver, which takes 1 second. It takes 2 seconds to pick up a heavy item (weight in pounds greater than your ST).

ST	1/2 to 10 lbs.	10+ to 50 lbs.	50+ to 100 lbs.	over 100 lbs.
5-6	1d-5	1d-4	1d-5	–
7-8	1d-4	1d-3	1d-3	–
9-10	1d-3	1d-2	1d-2	1d-3
11-12	1d-2	1d-1	1d-1	1d-2
13-14	1d-1	1d	1d	1d
15-16	1d	1d+1	1d+2	1d+2
17-18	1d+1	1d+2	2d-2	2d-1
19-20	1d+2	2d-2	2d-1	2d

RUNNING

In combat, running is just a series of Move maneuvers. Your running speed is your Basic Speed score, plus a one-yard-per-second "sprint bonus" if you are running in a straight line for more than one turn. This is modified downward by encumbrance (p. 228).

When figuring *long-distance* speed (i.e., for runs of a few hundred yards, as opposed to combat movement), do *not* round down your Speed. A Basic Speed of 5.5 would let you run 65 yards in 10 seconds, if you were unencumbered.

SWIMMING

Swimming short distances, your Move is equal to 1/10 your Swimming skill (round down), minimum 1 yard per second. Over long distances, the yards you swim in 10 seconds equals your Swimming skill minus *twice* your encumbrance. Swimming long distances can cause fatigue – see pp. 237-238.

Make a Swimming roll when you enter the water, and again every 5 minutes. Subtract *twice* your encumbrance level, and add 3 if you entered the water intentionally. Overweight characters (p. 210) get a bonus here. If you fail this roll, lose one point of fatigue (pp. 237-238) and roll again in 5 seconds, and so on until you reach ST 0 and drown, get rescued, or make the roll. If you recover, roll again in 1 minute. If you make that roll, roll again every 5 minutes.

To rescue a drowning person, make a Swimming roll at -5, plus or minus the difference in ST between you and the person you are rescuing.

THROWING THINGS

Anything you can lift – i.e., anything that weighs 25×ST lbs. or less – can be thrown. To hit a target, roll against DX-3 or Throwing skill. To lob something into a general area, roll against DX or Throwing. The distance you can throw an object depends on its weight and your ST. Find the weight nearest to that of the object on the table below, then multiply the distance listed there by your ST to get the distance, in yards, that you can throw it:

Throwing Skill: If you have the Throwing skill, divide it by 6 (round down) and add the result to your ST to determine how far you can throw something.

Throwing Things in Combat: Throwing an object during combat – whether as an attack or not – requires the Attack maneuver (p. 232). You must pick it up first, as described above. To see if you hit, roll against Throwing skill or an appropriate Thrown Weapon skill.

If you are hit by a (blunt) thrown object, the damage it does depends on its weight and the ST with which it was thrown (see table, left).

A fragile object (or a thrown character) will take as well as inflict this amount of damage. Roll damage separately for thrown object and target.

Weight	*Distance*
1 lb. or less	3.5
1 1/2 lbs.	3.0
2 lbs.	2.5
3 lbs.	1.9
4 lbs.	1.5
5 lbs.	1.2
7 1/2 lbs.	1.0
10 lbs.	0.8
15 lbs.	0.7
20 lbs.	0.6
25 lbs.	0.5
30 lbs.	0.4
40 lbs.	0.3
50 lbs.	0.25
60 lbs.	0.2
80 lbs.	0.15
100 lbs.	0.1
200 lbs.	0.05

MENTAL FEATS

SENSE ROLLS

Sense rolls include Vision, Hearing, and Taste/Smell rolls. All Sense rolls are made against the character's IQ. The Alertness advantage is a bonus to *all* Sense rolls.

Vision

To see something small or hidden, roll against IQ plus your level of Acute Vision (if any). The GM may make this roll easier or harder for things that are more or less well hidden. Partial darkness can give from -1 to -9. Those in *total* darkness – as well as those who have been blinded – can see nothing!

Hearing

To hear a faint sound, roll against IQ plus your level of Acute Hearing (if any). The GM may make this roll easier or harder, depending on the loudness of the sound, surrounding noises, etc. Once a sound is heard, a regular IQ roll may be required to *understand* its significance. Deaf characters can hear nothing!

Smelling and Tasting

These are two manifestations of the same sense. To notice an odor or a taste, roll against IQ plus your level of Acute Taste/Smell (if any). The GM may also require an IQ roll to *understand* the significance of a smell or taste.

WILL ROLLS

When someone is faced with a frightening situation, or needs to overcome a mental disadvantage, the GM should require a *Will roll*. Normally, Will is equal to IQ, so this is an IQ roll, but it is modified by the Strong Will advantage (p. 216) or the Weak Will disadvantage (p. 219).

On a successful Will roll, the character overcomes his fear, bad impulse, or whatever. On a failed roll, he is frightened, gives in, etc. Any Will roll of 14 or over is an automatic failure (this does *not* apply to Will rolls made to resist Influence Skills!).

COMBAT

Combat is treated in more detail than other skill use – a split-second decision can mean the difference between life and death, and a fight can be an exciting part of an adventure.

COMBAT TURN SEQUENCE

Characters act one at a time, until they have all taken a *turn*; then they start over. The *sequence* in which they act is set as follows:

Before combat, compare the Move scores of all characters. The highest Move goes first, the second-highest Move score goes next, and so on. In case of ties, the higher *Basic Speed* goes first; here is where a 5.25 is better than a 5, for instance. If anyone is *still* tied, roll dice to see who goes first.

Your turn *starts* when you choose a maneuver and *ends* when you choose your next maneuver; i.e., after *all* other characters have acted once. Each turn represents *one second* of real time.

MANEUVERS

Start your turn by choosing any one of the following maneuvers. You do not select a defense (p. 233) until you are actually attacked – but the chosen maneuver affects the defenses you can use.

Move

Move, and do *nothing* else (except for a "free" action – see below). You may use any legal active defense. Movement and special actions are wholly abstract; no gameboard is required. If a detail is important ("How long will it take me to run across the clearing and reach cover?"), the GM decides. The number of yards you can run per second is equal to your Move score.

Change Position

Go from standing to prone, kneeling to standing, or any other position change. (It takes two turns to go from prone to standing: first kneel, then stand.) *Exception:* You can go from kneeling to standing, or vice versa, and attack on the same turn. You can use any defense on a turn you change position.

Ready

Ready any weapon or other item. A weapon is "unready" if it is holstered, sheathed, or slung; it takes one turn to take it out. It also takes one turn to toggle the safety switch on a gun, or to cock a fully automatic weapon. A hand grenade takes *two* turns to ready: one to grab it and one to pull the pin. An unbalanced hand weapon, such as a swung rifle, becomes "unready" when you swing it; it must be readied again before each use!

Reloading a gun by changing magazines or power packs also requires a Ready maneuver. This usually takes 3 seconds.

You can parry with a hand weapon as soon as you have readied it – that is, on the same turn! You can also use any other legal active defense on the turn when you ready an item. *Exception:* If you are reloading a gun, your only defense is to dodge – and if you dodge, you lose the benefit of that turn of reloading. Note that, even if you are ambidextrous, you cannot ready one weapon on the same turn you attack with another.

SETTLING RULES QUESTIONS

In any question of rules, the GM's word is *law.* The GM decides which optional rules will be used, and settles any specific questions that come up. A good GM will discuss important questions with the players before deciding; a good player accepts the GM's decision once made.

When a situation is not covered by the rules, there are several techniques that can be used:

Success rolls. Roll 3 dice to test a character's strength, dexterity, skill, or whatever. Use a success roll when a question arises about someone's ability to do some particular thing.

Random rolls. For a question like "is the guard asleep?" a random roll is often best. The GM decides what the chances are, and rolls the dice, leaving the rest to fate.

Arbitrary fiat. You don't have to use the dice at all. If there is only one "right" answer to fit the plot of the adventure – then that's the answer.

Aim

Aim a ready *ranged* weapon. You must indicate a specific target. Your attack is at -4 if you use a ranged weapon without aiming *unless* your effective skill is at least equal to the weapon's *Snap Shot* number. If you aim for 1 turn, your attack is at your normal skill level plus the weapon's *Accuracy* modifier. You may aim for up to 3 more turns, getting a further +1 bonus per extra turn you aim. Guns get *another* +1 if they are braced (on a bipod, window sill, or the like) while aiming.

You can use any defense while aiming . . . but it spoils your aim and you lose all the accumulated benefits. If injured while aiming, you must make your Will roll or lose your aim.

Attack

Attack any foe you can reach (or who is in range) with your ready weapon. You may parry (with a ready hand weapon) or dodge on the same turn you attack.

All-Out Attack

Attack a foe with hands, feet, or a ready hand weapon, with no thought to self-defense. You have three choices:

1. Make two attacks against the same foe, if you have two ready weapons, or one weapon that does not have to be readied after use.

2. Make a single attack, at a +4 bonus to your skill!

3. Make one attack, at normal skill, doing +2 damage if you hit.

If you choose an All-Out Attack, you get *no active defenses at all* until your next turn!

All-Out Defense

Defend yourself, doing nothing else this turn. If you fail your defense roll against any attack, you may try *another* (different) defense – in other words, you get two defense rolls, using two *different* active defenses against the same attack. You are limited to *two* parries per turn when you choose All-Out Defense, but you can't parry twice with a weapon that becomes unready after a parry.

Long Action

This is a "generic" choice that allows for one second's worth of *any* multi-second action (e.g., performing first aid or defusing a bomb). The GM decides how many turns each "long action" takes. As a rule, no defense except dodging is possible during a long action, but the GM can vary this as he sees fit. Any sort of defense may also interfere with whatever you are trying to do.

Free Actions

Things you can do during any maneuver, including talking, dropping a weapon or other object, and crouching down behind cover (not kneeling).

MAKING AN ATTACK

If you choose the *Attack* or *All-Out Attack* maneuvers, you may try to hit a foe. You may attack any foe, unless the GM rules that attack is impossible for some reason. The GM always has the option of ruling that some combatants may not attack certain foes because they are out of range, behind cover, etc. If a fight is in extremely close quarters, rifles should only get one shot each – then the fight goes to PDWs, pistols, armguns, knives, fists . . .

You can only attack with a weapon if it is *ready.* A balanced hand weapon (e.g., a knife) is ready every turn. An unbalanced hand weapon (e.g., a swung rifle) becomes unready when you swing it, so it can only be used every other turn. A gun is ready when it is loaded and in hand with the safety off.

Each attack is resolved by three die rolls. First is your *attack roll*. If this roll is successful, your attack was a good one. Now your *foe* can try a *defense roll* to defend against your attack. If he makes this roll, he is not hit. If he misses his defense roll, your attack struck home and you *roll for damage.*

Rolling to Attack

Your "attack roll" is a regular success roll. Figure your *effective* skill (your *basic skill* plus or minus any appropriate *modifiers)* with the weapon you are using. Applicable modifiers include:

Attacker is Crawling or Lying Down: -4, except with a gun.

Attacker is Crouching, Sitting, or Kneeling: -2.

Attacker is in a strange position (e.g., hanging upside down): -2 or more (GM's decision).

Bad footing: -2 or more (GM's option).

Bad light: -1 to -9 (GM's decision); -10 for total darkness.

Blind: -6; blinded *suddenly:* -10.

Off-hand attack: -4 (no penalty if Ambidextrous).

ST under minimum ST for that weapon: -1 for each point of difference.

Wounds: Penalty equal to hits you took on the preceding turn. High Pain Threshold eliminates this penalty.

See p. 234 for additional modifiers that apply only to ranged attacks.

Now roll 3 dice. If your roll is *less than or equal to* your "effective" skill, you rolled well enough to hit the foe, and he must roll to defend. Otherwise, you missed!

Critical Hits: No matter what your skill, a roll of 3 or 4 always hits, and is a *critical hit.* If your effective skill is 15, then any roll of 5 or less is a critical hit. If your effective skill is 16 or more, then any roll of 6 or less is a critical hit.

On a critical hit, the attack automatically hits home – your foe does *not* get a defense roll. As well, on an attack roll of 3, you do not roll for damage – your attack automatically does the *most* damage it could do. For instance, maximum damage for 3d+2 would be 18+2, or 20 hits. Other critical hits bypass the defense roll, but roll normally for damage.

Automatic Misses: Regardless of skill, a roll of 17 or 18 always misses. At the GM's option, a weapon may break, malfunction, or be dropped.

DEFENSE

If you make your attack roll, your attack is *good enough* to hit your foe – *unless* he defends. *Exception:* Your foe does not get to attempt a defense roll if you rolled a critical hit!

Your foe's defense is equal to the sum of his armor's *passive* defense (PD), if any, and his *active* defense (Dodge or Parry). Passive defense always protects, but active defenses must be specifically chosen from those that are "legal" at the moment. This depends on the maneuver the defender chose on his last turn – see pp. 230-231.

The defender indicates the defense he is using and rolls 3 dice. If his roll is *less than or equal to* his total defense, he dodged or parried your attack. Otherwise, his defense was ineffective and your attack struck home. If your attack hits your foe, you can roll for damage.

A defense roll of 3 or 4 is *always* successful – even if your total defense is only 1 or 2! A roll of 17 or 18 always fails.

Active Defense

Two *active defenses* can protect you against an attack: Dodge and Parry. Each is calculated in advance. When you are attacked, you may choose *one* active defense as part of your total defense roll. (If you took *All-Out Defense,* you may make *two* separate defense rolls, using different defenses.)

Your active defense will depend on your situation – *especially* the maneuver you chose last turn. Some attacks or maneuvers limit the active defenses you can make. A stunned character's active defense is at -4.

Sometimes you will have *no* active defense. A knife from behind, a sniper's shot, or an unexpected booby trap would be attacks against which no active defense is possible.

Combat Reflexes (p. 215) gives +1 to active defenses.

Dodging

Your Dodge defense is the same as your Move score. You may dodge *any* attack, except one that you did not know about! You may even make a Dodge roll against a gun or beam attack made by a foe you can see (this represents the effects of evasive action – you don't actually dodge bullets!). There is no limit to the number of times you may dodge *different* attacks in one turn.

Parrying

Hand weapons (batons, knives, etc.) and bare hands can be used for defense as well as offense, but only against unarmed, hand-weapon, and thrown-weapon attacks – not bullets or beams!

When you parry with a weapon, *half* your skill with that weapon (round down) counts as active defense. Thus, if you have a Shortsword skill of 19, you have a Parry defense of 9 with a baton.

You cannot parry with a weapon unless it's *ready.* Parrying with an unbalanced weapon makes it "unready." For instance, you can't shoot a rifle on the same turn you parried with it; you'd have to re-ready it first.

If a weapon is used to parry anything of three or more times its own weight, it *breaks* on a roll of 1 or 2 on 1d! (The parry still counts, however.)

You may only parry one attack per turn, unless you have two weapons (in which case you may parry once with each weapon) or you chose the *All-Out Defense* maneuver (in which case you may parry twice – or twice with each weapon, if you have more than one).

If you successfully parry a barehanded attack with a weapon, you may injure your attacker. Immediately roll against your own weapon skill (at -4 if your attacker used Judo or Karate). If you hit, your parry struck the attacker's limb squarely; roll normal damage.

Some special parrying rules:

Knives and equally small weapons are at -1 to parry *with.*

Rifles used in hand-to-hand combat parry at 1/2 Two-Handed Axe/Mace skill. Roll 1d after every parry; on a 1, the gun is damaged, and will require repairs before it can fire again.

Thrown knives and similar small, hurled weapons are parried at -2.

Parrying Barehanded: You may parry a *kick* or *punch* with your hands. Your Parry is the best of 1/2 your DX or 2/3 your Brawling, Judo, or Karate skill, rounded down. If you parry a *weapon* barehanded, you are -3 unless the weapon is a thrusting weapon or you are using Judo or Karate.

Passive Defense (PD)

If you are wearing armor (or have natural armor), you will usually have a "passive" defense factor protecting you as well. Armor PD ranges from 1 to 6; see pp. 159-161. Passive defense *always* protects you. It normally adds to a dodge or parry, but if neither is legal (e.g., you're immobile, unconscious, or unaware of the attack), you can roll against PD alone. If you have any PD at all, a defense roll of 3 or 4 will succeed for you!

DAMAGE

Rolling for Damage

If an enemy fails his defense roll, you have hit him and may make a "damage roll." This roll tells how much damage you did to your target. Your weapon (and, for hand weapons, your strength) determines the number of dice you roll for damage.

If the enemy is wearing armor, the armor's Damage Resistance (DR) is subtracted from the damage you roll. If you roll enough damage to exceed your foe's DR, you will injure him.

Injury

If the total damage you roll *exceeds* your foe's Damage Resistance (armor, skin, etc.), the excess hits are taken as damage. *Example:* Your assault pod's "Damage" statistic is 3d+2. You roll 3 dice, add 2, and get a 12. The target's arachnoweave vest gives 8 points of DR, so 4 points of damage get through, and the target takes 4 hits of damage. Remember that cutting and impaling attacks get bonus damage (see *Damage Types and Damage Bonus*, p. 227).

Effects of Injury

All injuries are assumed to be to the torso; specific hit locations are beyond the scope of ***GURPS Lite.*** Subtract the hits you take from your HT score. See *Injury, Illness, and Fatigue* (pp. 236-238) for more details.

Unarmed Combat

Anyone can engage in unarmed combat, but certain skills – Brawling, Judo, and Karate – will make you a more effective at it.

Punching: A punch is an attack. Your "skill" for a punch is the best of DX, Brawling, or Karate. It inflicts thrust-2 crushing damage, determined from your ST using the table on p. 227. *Example:* With ST 12, your thrust damage is 1d-1, so your punch does 1d-3 damage. Add +1 damage for a rock in the fist, +2 for brass knuckles.

Kicking: A kick is an attack at DX-2, Brawling-2, or Karate-2. It does thrust crushing damage, +1 if wearing heavy boots. If you *miss,* you must make a DX or skill roll to avoid falling down!

Brawling and Karate: Add the *higher* of 1/5 Karate skill or 1/10 Brawling skill, rounded down, to punching or kicking damage.

Ranged Weapons

Ranged weapons work like other weapons: make your attack roll, let your foe make his defense roll, and then roll for damage if you hit. Some additional rules apply, however.

Guns, beam weapons, thrown knives, etc. can be fired at any target you can see, if nothing's blocking the line of fire. Figure your attack roll by:

1. Starting with your base skill with the weapon. In most cases, this is the Beam Weapons, Guns, or Gunner skill noted on the *Weapon Table* (p. 156). For thrown weapons, this is the general Throwing skill or the specific Thrown Weapon skill for that weapon.

2. Modifying for the target's *speed and range* (handled as a single modifier) and *size.*

3. Adding the weapon's *Accuracy* (Acc), if you took at least one turn to aim. The bonus from Acc cannot exceed your basic skill.

4. Applying situational modifiers (cover, darkness, etc.).

5. Applying an extra -4 if you have not aimed and your modified skill is less than the weapon's Snap Shot (SS) number.

The result is your *effective skill.* A roll of this number, or less, is a hit.

Weapon Statistics

A ranged weapon has several specialized statistics; see p. 156. These numbers, and their effects on game play, are:

Dam: The damage it inflicts, expressed as "dice + adds."

SS: The Snap Shot number; see step 5, above.

Acc: The Accuracy number; see step 3, above.

1/2D: Half-Damage range. The range (in yards) past which the weapon does only half normal damage. Roll normally and divide by 2 (round down). If a target is beyond 1/2D, you do not receive your weapon's Acc bonus, even if you have aimed!

Max: Maximum range. The range (in yards) past which no attack is possible with the weapon.

RoF: Rate of Fire. How often the weapon can fire each turn. RoF 1/3 means it can fire every third turn; two turns are required to load a new shot. RoF 1 means it can fire once per turn. RoF 3~ indicates a semi-automatic weapon that can fire up to three times per turn as a single maneuver, requiring a separate attack roll each time. RoF 4 or more is an automatic weapon (see p. 235); a * means it can fire as if RoF 3~ *instead,* if desired.

Shots: Shots per magazine, power pack, etc. After this many shots, the weapon won't fire again until you reload.

Rcl: Recoil. If a gun is fired more than once, in the same or consecutive turns, without pausing for one turn between shots, this penalty is subtracted from the *second* and subsequent shots. Double Rcl if your ST is below the "ST" listed for the weapon. Automatic weapons use Rcl differently; see p. 235.

Situational Modifiers

In addition to the modifiers in *Rolling to Attack* (p. 232), the following situational modifiers apply to ranged attacks:

The target is . . .

Behind light cover (e.g., bushes): -2.

Behind moderate cover (e.g., a tree, a doorway): -3.

Behind someone else: -4.

Firing a weapon from a trench: -4.

Crouching, sitting, or kneeling: -2, -4 if behind cover.

Prone or crawling: -4, -7 if behind cover.

Moving forward evasively (at half Move): -1.

Moving evasively at the cost of forward progress (Move 1): -2.

The attacker is . . .

Walking (Move 1-2): -1.

Running (Move 3+): -2.

Speed/Range and Size Modifiers

Ranged attacks take modifiers for the target's speed and range (treated as one modifier), and for its size. These are determined from the chart on the next page, as follows:

Speed/Range: Look up the *sum* of range to the target (in yards) and the target's speed (in yards per second) in the third column, and then read the modifier in the first column. Ignore speed (but not range) when attacking a human target.

Size: Look up the target's size in the third column, rounding up to the next larger size, and then read the modifier in the second column. Ignore size when attacking a human target.

Speed/Range and Size Table

Speed/Range Mod	Size Mod	Size, Range, or Speed (in yd or yd/sec)	Speed (in mph)
+2	-2	1 yd	2 mph
+1	-1	1.5 yd	3 mph
0	0	2 yd	4.5 mph
-1	+1	3 yd	7 mph
-2	+2	4.5 yd	10 mph
-3	+3	7 yd	15 mph
-4	+4	10 yd	20 mph
-5	+5	15 yd	30 mph
-6	+6	20 yd	45 mph
-7	+7	30 yd	70 mph
-8	+8	45 yd	100 mph
-9	+9	70 yd	150 mph
-10	+10	100 yd	200 mph
-11	+11	150 yd	300 mph
-12	+12	200 yd	450 mph
-13	+13	300 yd	700 mph
-14	+14	450 yd	1,000 mph
-15	+15	700 yd	1,500 mph
-16	+16	1,000 yd	2,000 mph
-17	+17	1,500 yd	3,000 mph
-18	+18	2,000 yd	4,500 mph
-19	+19	3,000 yd	7,000 mph
-20	+20	4,500 yd	10,000 mph

Automatic Weapons

Automatic weapons are handled like other ranged weapons, except as follows. An automatic weapon will fire for as long as the trigger is held. The shots fired by one trigger pull are a *burst.* The Rate of Fire (RoF) for an automatic weapon is the number of rounds it fires *each turn*. It is rare for all rounds in a burst to hit the target. To simulate this, the burst is divided into *groups* of 4 shots (if RoF does not divide evenly by four, any remaining shots form a group of 1, 2, or 3 shots). A separate roll to hit is made for each group.

The table below shows the number of shots that hit, depending on the attack roll. Even failure by 1 can result in a hit!

A critical hit with a group of shots is a hit with all the rounds. Treat one round in the group as a critical hit, the rest as normal hits.

Recoil: When firing an automatic weapon, apply Rcl as a penalty to effective skill on the attack roll for the *first* group, and again on the roll for each four-round group or partial group after the first. E.g., for a weapon with RoF 12 and Rcl -1, the first 4 rounds are at -1, the second 4 at -2, and the final 4 at -3. This penalty continues to accumulate over subsequent turns until the firer stops shooting for one full turn.

Rounds	***Roll Made by***						
in Group	**-1**	**0**	**1**	**2**	**3**	**4**	**5+**
1	0	1	1	1	1	1	1
2	0	1	1	1	1	1	2
3	1	1	1	1	2	2	3
4	1	2	2	3	3	3	4

Area Effect: A burst can be played over several targets in one turn. All these targets must be within a 30° angle. The targets must be engaged in succession, and the firer must announce, before rolling to hit, how many rounds he uses on each one. Calculate the attack separately for each target. If the targets are more than one yard apart, traversing between targets wastes some rounds: one round is lost per yard between targets.

Grenades and Smart Warheads

These can affect an area, so even if you miss, *someone* may get hurt. Roll against Throwing skill or DX to lob a grenade (p. 159), or against an appropriate Guns skill to fire a weapon with a smart warhead. Apply all the rules and modifiers above. If you miss, you missed your target by a number of yards equal to the amount by which you failed or half the distance to the target (round up), whichever is *less.* Roll 1d for direction: on a 1, it goes long; on a 2-5, it lands to one side; and on a 6, it falls short of the target, which may endanger *you!*

Defense Against Ranged Weapons

Thrown Weapons: The target of a thrown weapon may dodge, or parry at -2. Against a grenade, only a dodge is effective – and only if there's cover to duck behind.

Guns and Beam Weapons: The target may only dodge; he may not parry.

Automatic Weapons: As per guns, but the target rolls against Dodge for each *group,* regardless of how many rounds it contains. Success means the entire group misses him; failure means the entire group hits him. Roll damage separately for each round that hits and apply DR separately against each round.

EXPLOSIONS

Explosives (see *Smart Warheads*, p. 158) do *concussion damage* and *fragmentation damage.* Both types of damage are *doubled* for anyone in contact with the explosive when it goes off. PD has no effect on either type of damage, and no active defense is possible against an explosion.

Concussion: Damage due to the shock wave. This is applied to *everything* nearby. For blasts up to 6d×20, apply full damage to anyone within 2 yards. More distant targets divide damage by 4 per 2 yards range (1/4 at 2 yards, 1/16 at 4 yards, and so on). Each tenfold increase in the amount of concussion damage doubles the increment at which damage is quartered. The DR of armor does not protect against concussion, unless it's sealed. The DR of sealed vehicles, cybershells with Vacuum Support, or structures is *squared* vs. concussion.

Fragmentation: Most explosive munitions are designed to produce lots of metal fragments. Fragmentation damage is given in square brackets after concussion damage; e.g., 2d[2d] means "2d concussion, 2d fragmentation." An explosion projects fragments to a distance of 5 yards times the dice of concussion damage. A hit is automatic at "ground zero." At 1 yard from the blast, a hit occurs on a roll of 17 or less. At 2 yards, the roll is 16 or less, and so on. When this roll reaches 3, it stays at 3 to the limit of fragment range. DR protect normally against fragmentation. Fragmentation damage is considered cutting damage.

INJURY, ILLNESS, AND FATIGUE

The life of an adventurer is not all song and glory. You can get tired, *hurt,* or even *dead.*

Wounds and other injuries cause bodily damage, or "hits." Your HT score tells how many hits you can take. A character who goes down to 0 hit points will soon fall unconscious. It *is* possible to survive with a negative hit-point total.

GENERAL DAMAGE (LOST HIT POINTS)

Someone who is wounded repeatedly will eventually weaken and collapse, even if no single injury is very great. Record hits on your character sheet. The effects of lost hit points are:

3 or less hit points left: Your Move and Dodge are cut in half; you are reeling from your wounds.

0 or less hit points left: You are in immediate danger of collapse. At the beginning of each turn, roll against your basic HT, plus or minus Strong or Weak Will. A success means you may take your turn normally. A failed roll means you fall unconscious.

-HT hit points: You must make your HT roll (use basic HT) or die. Another roll is required after each further loss of 5 hit points.

-5×HT: Automatic death. You have lost a total of 6 times your original hit points; no one can survive that much injury.

DEATH

A dead character is out of the game, unless he has an Extra Life (p. 129) or is uploaded (p. 167). If your PC dies, you can create a new character, introducing him in the next game session with the GM's help.

SHOCK

When you are injured, your DX and IQ, and any skills based on DX and IQ, are reduced by that amount, *on your next turn only. Example:* If you take 3 hits of injury, your IQ, DX, and skills will be at -3 on your next turn. Active defenses are *not* reduced.

This subtraction will most often affect weapon attacks – but *any* use of IQ, DX, or skills is affected. Therefore, on the turn after you are badly hurt, it may be a good idea to try flight, All-Out Defense, or the like, rather than counterattacking instantly.

This is only a temporary effect due to shock. On your following turn, your skills are back to normal.

KNOCKDOWN

Anyone who takes damage *greater than* half his HT (modified by any Extra or Reduced Hit Points) in one blow must immediately roll against his basic HT. If he fails the roll, he *falls* and is *stunned* (see below). If he makes his HT roll, he keeps his footing, but he is still stunned.

STUNNING

Someone will be "stunned" if he takes damage *greater than* half his HT in one blow.

If you are stunned, all your active defenses are at -4 until your next turn. At that time, roll against basic HT. A successful roll means you can act normally *on that turn.* A failed roll means you are still stunned and stand there mindlessly . . . The "stunned" state continues until you can make your HT roll and snap out of it. You may act again on the turn you do so.

Mental Stun: Someone who is surprised or shocked may be *mentally* "stunned." The effects of this sort of stunning are just the same, but you must make your IQ roll, rather than your HT roll, to snap out of it. You're not *hurt* – you're *confused.*

FIRST AID

Most of the HT loss from an injury is due to shock rather than actual physical damage. Therefore, prompt treatment after a fight can restore some of the lost hit points.

Simple Bandaging: Basic, unskilled bandaging will restore 1 lost hit point per fight – but no more, no matter how bad the injury. This takes 30 minutes per victim.

First Aid: See p. 161. On a critical success, the victim regains the maximum. On a critical failure, the victim *loses* 2 hits, and bandaging will not help. Barring critical failure, 1 point is always restored. First aid is *not* cumulative with simple bandaging.

NATURAL RECOVERY

Natural recovery will cure any number of hits. At the end of each day of rest and decent food, the victim may roll against his *basic HT.* A successful roll results in the recovery of 1 hit point. The GM may modify the roll downward if conditions are bad, or upward if conditions are very good.

A victim under the care of a competent physician (Physician skill level 12+) gets +1 on all healing rolls and may roll *twice* daily to recover.

Recovering From Unconsciousness

If your HT is still positive, roll vs. HT every hour to awaken (or, if you have lost no more than 2 HT, roll every 15 minutes).

If your HT is negative, but not *fully* negative, you regain consciousness in as many hours as your HT is negative, or a maximum of 12 hours. When you awaken, you can call for help or even try to drag yourself to shelter.

If your HT has gone *fully* negative – e.g., HT of -10 or worse for someone with a basic HT of 10 – you are in bad shape. If you can make a roll on basic HT, you will awaken (as above) after 12 hours, and can try to help yourself. If you fail the roll, you stay in a coma and die unless you are helped within HT hours.

OTHER HAZARDS

Adventurers often face other dangers: the hazards of extraterrestrial space (pp. 53-60), as well as . . .

Falling

When you fall, roll for damage as follows:

1 or 2 yards: (1d-4) damage per yard.

3 or 4 yards: (1d-3) per yard.

5 or more yards: (1d-2) per yard.

If you land on something soft, subtract 1 point per yard fallen. A successful Acrobatics roll will reduce the effective distance of your fall by 5 yards. The Catfall advantage (p. 225) also reduces falling damage.

Terminal velocity – the maximum speed a falling object can achieve – varies for humans, but is normally reached after 3 or 4 seconds of falling. Therefore, treat any fall of more than 50 yards as only 50 yards.

Armor protects against falling damage at *half* its usual DR.

Flame

Walking through fire does 1d-3 damage per second; actually *standing* in fire does 1d-1 damage per second. Armor protects completely against ordinary heat or flame for a number of turns equal to 3 times its DR. After that, it still protects against flame, but the wearer must roll vs. HT every turn to resist the heat of the fire. A failed roll costs 1 point of fatigue (below).

ILLNESS

Anyone in a disease-ridden area, or encountering a disease carrier, is in danger of contracting the disease. (*Exception:* Immunity to Disease, p. 215, protects wholly against disease.) Most diseases allow a HT roll to resist, made in secret by the GM. Roll against HT once per day; a failed roll means you catch the disease. From the table below, choose the least advantageous roll:

Avoided all contact with possible victims: HT+4
Entered dwelling or shop of victim: HT+3
Spoke with victim at close quarters: HT+2
Touched victim briefly: HT+1
Used victim's clothes, blankets, and so on: HT
Ate victim's cooked flesh (animal, we hope!): HT
Ate victim's raw flesh (ditto!!): HT-1
Prolonged contact with living victim(s): HT-2
Kissing or other intimate contact with victim: HT-3

The GM may require a harder roll for a virulent plague, or an easier one for a less contagious one.

Symptoms

Disease symptoms usually appear at least 24 hours after the disease is caught. Most diseases aren't contagious until after symptoms appear. Typical symptoms include daily HT loss (which may endanger the victim) for several days; loss of ST, DX, or IQ; fatigue; sneezing, coughing, spots, sores, or a rash. Severe symptoms could include delirium, unconsciousness, blindness, etc.

Diagnosis

When symptoms of a disease are apparent, the GM should roll against the character's Diagnosis skill, or IQ-6, in secret. Success means he identifies the disease.

Recovery

Typically, a disease sufferer must make a daily HT roll – possibly at a penalty. This roll and the effects of failure vary with each illness. For a "generic" disease, a failed roll might mean you lose 1 HT; a success would let you regain 1 HT.

When you have recovered all HT lost to an illness, you are cured. If your illness allows HT rolls to attempt to recover, a roll of 3 or 4 means the disease has vanished (lost HT must be recovered in the normal fashion).

For some diseases, recovery will be aided by use of appropriate drugs. For most diseases, a physician's care (as for injuries) will aid attempts to recover.

FATIGUE

Fatigue represents lost ST, just as injury represents lost HT. If your ST is 10, you can lose 10 "fatigue points" before falling unconscious from exhaustion. Keep separate track of fatigue you lose or regain. Fatigue does not affect HT at all.

You can suffer fatigue from exertion, running long distances, heatstroke, etc. You will also suffer fatigue at the end of each battle that lasts more than 10 seconds; the amount is equal to your encumbrance level plus 1.

While your ST is reduced due to fatigue, any Contest of ST, attempt to lift or throw an object, or other use of ST is made at the reduced ST score; your score in any ST-based skill is similarly reduced.

The basic damage you do with hand weapons is unchanged. This is for playability, to avoid constant refiguring of weapon effects!

Likewise, your Move score is not affected by fatigue *until your ST reaches 3.* At that point, cut your Move in half, rounding down.

If fatigue reduces your ST to 0, you fall unconscious and automatically rest until your ST reaches 1 and you awaken. You cannot have "negative" fatigue or a "negative" ST.

Sample Fatigue Costs

Marching: Each hour of road travel costs fatigue equal to your encumbrance level +1. Add 1 more in hot climates.

Running or Swimming: After each 100 yards traveled, roll vs. HT. A failed roll costs 1 point of fatigue.

Overexertion: Carrying more than 20 times ST, or pushing or pulling a very heavy load, costs 1 fatigue per second.

Losing Sleep: A night without sleep costs 5 fatigue. A half-night of sleep costs 2 fatigue.

Recovering from Fatigue

A fatigued character will regain his lost ST at the rate of 1 point per 10 minutes of rest. Talking and thinking are allowed; walking, or anything more strenuous, is *not* rest! The GM may allow an extra point of fatigue to be regained if you eat a decent meal *while resting.*

Fatigue due to *lost sleep* is regained only by getting a *full* night of sleep! This restores *all* lost fatigue.

CAMPAIGNS

The following topics are liable to arise in the course of running a campaign; see pp. 26-27 for campaign ideas.

ADVENTURES

The GM should usually prepare for an adventure before a game session. This involves determining a way to motivate and involve the PCs (e.g., a rich or interesting person hires them to solve a problem). Make notes (or diagrams) to help describe events or locations the adventurers may encounter, create a few interesting NPCs the PCs may interact with, and devise challenges or obstacles that require wit, negotiation, skill use, or combat to overcome!

JOBS

Characters' lives may be devoted entirely to adventuring, or they may have more mundane jobs they perform in between; see p. 138. Five things define a job:

Description: The job's title, and what the job entails.

Prerequisites: The skills or advantages needed to do the job, and the minimum required level in each.

Success Roll: At the end of every month in which you work, roll against the listed prerequisite skill ("PR") for your job – or in some cases, your HT or IQ. If you roll anything but a critical success or a critical failure, collect your *monthly income* and go on. On a critical success, you get a 10% permanent raise. Results of a critical failure vary; loss of one or more months of income (-1i, -2i, etc.) or being fired is typical, but an on-the-job injury (doing 1d, 2d, etc. of damage) is also possible. The GM should interpret all results!

Monthly Income: The amount of money earned on a successful roll.

Wealth Level: Each job has a *wealth level: poor, struggling, average, comfortable*, or *wealthy*. This is the minimum level of wealth the *character* must have if he holds that job. Very Wealthy and Filthy Rich characters get "wealthy" jobs, but the Very Wealthy take home twice the listed pay for any job, and the Filthy Rich get 10 times the listed pay!

GAME TIME

Game time is the time that passes in the game world. The GM judges how much time has passed.

Time During Adventures

Personal combat is played out in "slow" time. One combat turn equals one second. It may take a minute or so of real time for each combat turn, especially if the players are inexperienced or the battle is large. But combat is usually life-or-death, and you need to give players time to think.

Conversations, negotiations, attempts to pick locks, and similar situations are played in "real" time. If the players spend 10 minutes debating how to best approach an NPC informant . . . their *characters* spent 10 minutes talking on the street.

Routine travel, and so on, is handled in "fast" time. When the adventurers voyage from Islandia to Mars, for instance, the GM can simply skip the month-long travel time. Tell the players when they encounter an interesting NPC, or arrive at their destination. Just compress the rest of the time.

Time Between Adventures

In a continuing campaign, you also need to keep track of time between adventures. This can always be the same amount of time, or the GM and the players can agree on a "logical" time to pass between the end of one adventure and the start of the next. It can be a good idea to let a month or two go by, to allow for healing, "ordinary" jobs, interplanetary travel, etc.

Of course, no game time at all has to pass between *sessions*, if you can't finish an adventure in one session. If, when you quit play, the heroes have just spotted an approaching horde of devourer microbots, the cyberswarm will get no closer in the real-world week before you can play again!

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